

CONTRACTORS HANDY BOOK

*—on everyday
concrete jobs*



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CONTRACTORS HANDY BOOK

*—on everyday
concrete jobs*

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LEHIGH PORTLAND
CEMENT COMPANY

LEHIGH PORTLAND CEMENT COMPANY

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Mills

West Coplay, Pa.

Birmingham, Ala.

Chapman, Pa.

Mitchell, Ind. (2 mills)

Ormrod, Pa. (3 mills)

Oglesby, Ill.

Sandt's Eddy, Pa.

Mason City, Iowa

New Castle, Pa. (3 mills)

Iola, Kansas

Fordwick, Va.

Metaline Falls, Wash.

Alsen, N. Y.

Bath, Pa.

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ALLENTOWN, PA.

Second Edition

TABLE OF CONTENTS

PLANS AND MATERIALS FOR

	PAGE
Barn Approach.....	51
Curbs, Separate.....	36-38
Integral, and Gutter.....	39
Driveway.....	32
Floors, Porch.....	11
Garage.....	28
Poultry House.....	60
Garage.....	28
Garage Drives.....	19-27
Gutter, Integral, and Curb.....	39
Down-spout.....	4
Separate.....	36
Hog Houses.....	65
Hog Runs.....	63
Manure Pits.....	71
Parapets, Lawn.....	13-18
Piers, Building.....	75
Posts, Hitching.....	41
Septic Tanks.....	42
Sidewalk.....	36
Steps, Entrance.....	2
Lawn.....	6
Small.....	4
Storage Cellars.....	54
Walks, Service.....	9
Through Lawn.....	6-7
Wallows, Hog.....	68
Watering Troughs.....	47

NOTES ON

Aggregates.....	87-105
Forms.....	83
Foundations.....	81-82
Reinforcing Steel.....	108

TABLES AND DATA

Areas and Weights of Steel Bars.....	108
Bearing Capacity of Soils.....	82

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	PAGE
Board Feet in Lumber	86
Colorimetric Test	100-101
Materials Required for 1 Cubic Yard of Concrete	107
Proportions for Concrete	106
Sand, Coarse	103
Fine	105
Medium	104
Silt Test	102
Volume of Concrete	99
Weights of Aggregates	98
Weights of Building Materials	111
Weights of Masonry	109
Weights of Material	109-110

PREFACE

THE publication of this book is the result of a realization, gained through our nation-wide contact with contractors, of the need for information that will assist in securing permanent satisfaction in concrete construction through the combination of dependable materials with competent workmanship.

We trust that contractors will find within these covers many helpful ideas and suggestions which will be a real aid in solving the simple problems connected with small jobs in concrete construction. This is not a technical book, filled with scientific data, but is devoted exclusively to presenting practical information for every-day reference.

From these actual examples of good design and proper execution, contractors should be better able to demonstrate to customers the superiority of concrete construction with particular reference to its permanence, beauty and economy.

The rapid and substantial growth of this company is due in a great measure to the loyal patronage and confidence of contractors throughout the country. To merit this confidence always is our incentive for continuing to produce cement of the highest quality and uniformity. Also our 19 mills—from coast to coast—assure prompt delivery service to contractors in any part of the country.

Where perplexing problems are encountered which require advice, we welcome the opportunity to be of further service, and solicit such inquiries.

All information given has been carefully compiled and it is presented without guarantee or other obligation.

LEHIGH PORTLAND CEMENT COMPANY



Concrete Steps

CONCRETE steps are attractive and permanent. Being in contact with the moisture in the soil, steps should be constructed of a material that will not rot and decay, thus avoiding the necessity of periodical replacement.

Method

Tongued and grooved form lumber is preferable, as it makes a much tighter and smoother job. Forms should be entirely built and the cinders or gravel well soaked and packed in place before placing the concrete. In the two walls leave the short top boards out until the concrete work is started, they being set in place one at a time as the concrete rises, thus making it possible to spade the concrete well and eliminate the possibility of air holes or rock pockets in the surface.

The concrete should be mixed in proportions of $1:2\frac{1}{2}:4$, being 1 part of portland cement, $2\frac{1}{2}$ parts of sand, and 4 parts of stone or gravel graded in size from $\frac{1}{4}$ inch to $1\frac{1}{2}$ inches. It should be machine mixed if possible and water used sparingly. Place it all in one operation. This makes a monolithic structure and all joints are eliminated. The treads should be finished rough with a wood float, to make a safe, non-skid wearing surface. Special colored aggregates or bits of abrasive stone can be troweled into the wearing surface as an added precaution against slipping. After the forms are removed all exposed surface should be tooled or rubbed with an abrasive stone which will remove the laitance and all traces of form lines. This treatment will give the completed work a very pleasing appearance.

Materials

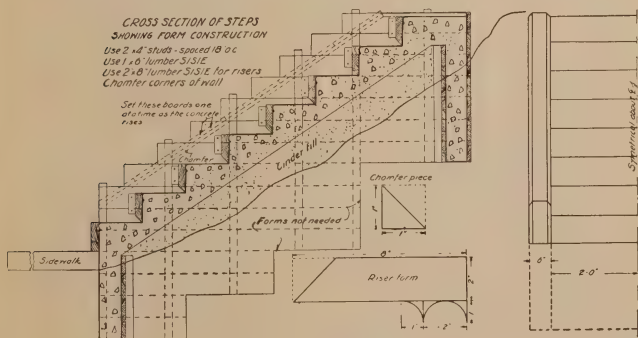
67 cu. ft. of concrete

Mixture, $1:2\frac{1}{2}:4$

Lehigh Cement 14 sacks

Sand, $\frac{1}{4}$ inch and under $1\frac{1}{3}$ cu. yds.

Stone, $\frac{1}{4}$ inch to 2 inches $2\frac{1}{6}$ cu. yds.



Cross-section of steps



Small Steps

THESE very unpretentious steps proved a most economical way of solving the owner's problem. Simple in construction and very low in cost, they serve as satisfactorily in every way as would a much more ornate and expensive type.

They are rigid and permanent, neat and pleasing in appearance. The gritty, non-skid texture of the finished concrete provides the safest possible surface for walking, and permits entrance without the necessity of crossing a wet and muddy lawn or walk.

The down spout runoff provides a solution to the rain water problem in localities where there are no sewage facilities. This is very quickly and easily built and will last indefinitely.

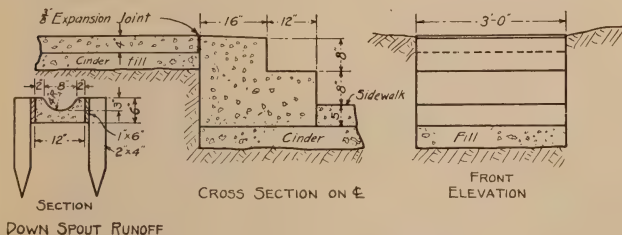
Method

Concrete for the walk and steps should be mixed in proportions of $1:2\frac{1}{2}:4$, being 1 part of portland cement, $2\frac{1}{2}$ parts of sand, and 4 parts of stone or gravel graded in size from $\frac{1}{4}$ inch to 1 inch. Mix the concrete as dry as possible to permit a workable mixture. Construction joints should be provided every six feet in both down spout runoff and sidewalk.

The top step should be pitched slightly toward the street, to insure a dry step and walk in all weather. The surface should be finished with a wood float.

The concrete for the down spout runoff is mixed very stiff, and in proportions of $1:2:3$, using one inch stone. This makes it possible to trowel the depression with a steel float and form a smooth waterproof trough.

	Steps	Walk	Down Spout Runoff
Length.....	as shown	24' 0"	20' 0"
Concrete.....	10 cu. ft.	24 cu. ft.	9 cu. ft.
Mixture.....	$1:2\frac{1}{2}:4$	$1:2\frac{1}{2}:4$	$1:2:3$
Lehigh Cement.....	2 sacks	5 sacks	3 sacks
Sand, $\frac{1}{4}$ " and under ..	$\frac{1}{5}$ cu. yd.	$\frac{1}{2}$ cu. yd.	$\frac{1}{5}$ cu. yd.
Stone, $\frac{1}{4}$ " to 1"	$\frac{1}{3}$ cu. yd.	$\frac{3}{4}$ cu. yd.	$\frac{1}{3}$ cu. yd.

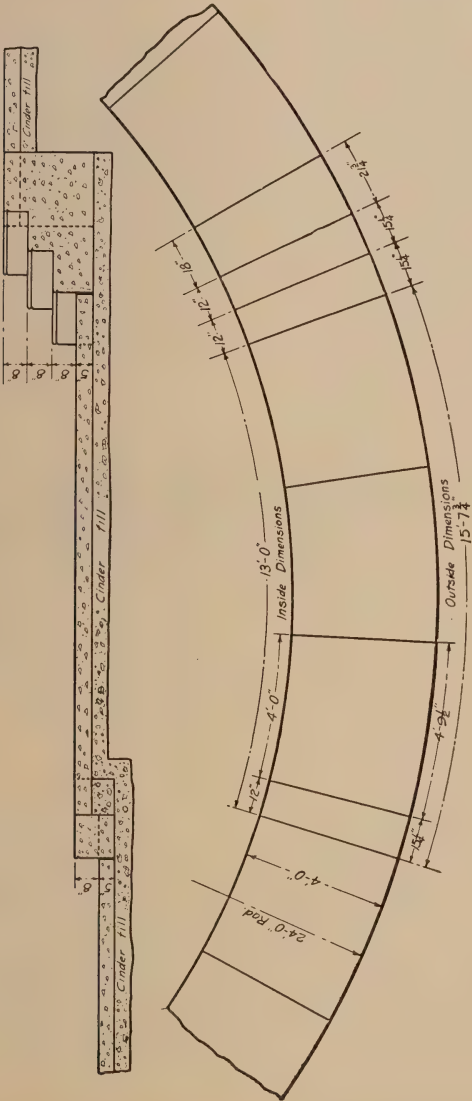


Details of construction for small steps



Walk and Steps through Terraced Lawn

THE possibilities of concrete in the improvement of suburban property are ably demonstrated in this picture. A little thoughtful planning will work wonders on the most modest of estates. First impressions are usually lasting, and concrete plays a considerable part in making first impressions favorable.



Curved walk and steps through terraced lawn

In addition to its beauty and attractiveness, consider its durability, permanence, and low upkeep.

Method

The steps must be separated from the walks by expansion joints $\frac{1}{4}$ inch thick; due to the difference in thickness, cracks will develop unless these are installed. All dimensions for the setting of forms should be taken from a stake set at the center of the circle, being 24 feet from the outside edge of the sidewalk and 20 feet from the inside.

The concrete should be mixed in proportions of $1:2\frac{1}{2}:4$, being 1 part of portland cement, $2\frac{1}{2}$ parts of sand, and 4 parts of gravel or stone graded in size from $\frac{1}{4}$ inch to $1\frac{1}{2}$ inches.

In scoring the pavement into slabs every four feet, as shown in the sketch, stretch a line from the center stake and take the four-foot measurement on the inside line of the walk.

Finishing is done with a wood float only, which provides a gritty, non-skid surface, and the completed work should be properly cured for at least a week.

Materials

12 ft. of walk

22 cu. ft. of concrete

Mixture, $1:2\frac{1}{2}:4$

Lehigh Cement..... $4\frac{1}{2}$ sacks

Sand, $\frac{1}{4}$ inch and under..... $\frac{4}{10}$ cu. yd.

Stone, $\frac{1}{4}$ inch to $1\frac{1}{2}$ inches... $\frac{7}{10}$ cu. yd.

Steps up, 3 treads

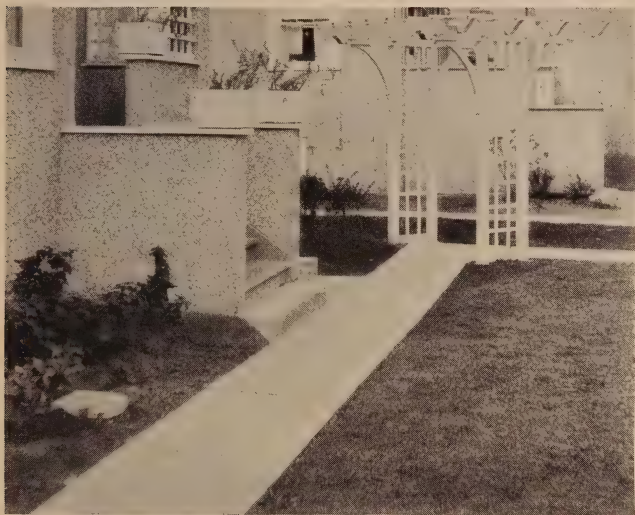
29 cu. ft. of concrete

Mixture, $1:2\frac{1}{2}:4$

Lehigh Cement.....6 sacks

Sand, $\frac{1}{4}$ inch and under..... $\frac{3}{5}$ cu. yd.

Gravel, $\frac{1}{4}$ inch to $1\frac{1}{2}$ inches.. $\frac{9}{10}$ cu. yd.



Service Sidewalk

A CONCRETE service sidewalk provides easy access to the rear of the house, and keeps dirt and dust out even in the most inclement weather. It is the best possible insurance against accidents—people don't often slip or trip on the gritty, non-skid surface of a concrete walk.

Method

The concrete should be mixed in proportions of 1:2½:4, being 1 part of portland cement, 2½ parts of sand, and 4 parts of gravel or stone graded in size from ¼ inch to 1½ inches.

Construction joints should be spaced six feet apart and an expansion joint provided every twenty-four feet; the surface should be finished with a wood float



only, and should be kept wet for six days to properly cure the sidewalk.

Materials

24 feet of sidewalk

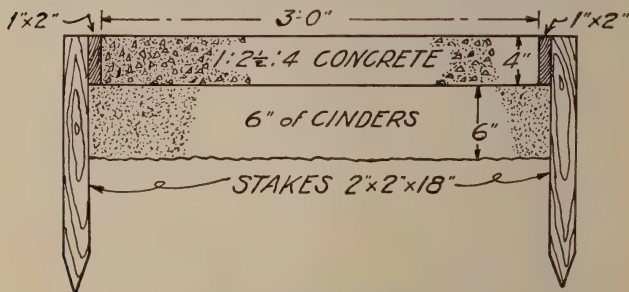
24 cu. ft. of concrete

Mixture, 1:2½:4

Lehigh Cement. 5 bags

Sand, ¼ inch and under. ½ cu. yd.

Stone, ¼ inch to 1½ inches. ¾ cu. yd.



Cross-section of sidewalk



Porch Floor

CONCRETE will provide a clean, sanitary surface for a porch floor. It is quickly and thoroughly cleaned with a hose without possibility of rot or deterioration. It presents a smooth, even, non-skid surface, and will not be the cause of constant repairs in years to come.

Method

The wall forms are first poured, using a mixture of 1:2½:4, being 1 part of portland cement, 2½ parts of sand, and 4 parts of stone or gravel graded in size from ¼ inch to 2 inches.

The floor form is then set rigidly in position and the reinforcing bars are placed either in "chairs" which raise them about an inch above the bottom of

the slab or else they are raised by placing shovelfuls of concrete under them. They should be carefully spaced properly to carry the load.

The concrete for the floor slab should be mixed in proportion of 1:2:3, being 1 part portland cement, 2 parts of sand, and 3 parts of stone or gravel, graded in size from $\frac{1}{4}$ inch to 1 inch. It should be mixed with as little water as possible and the surface should be finished with a steel float. It may be divided into squares of any desired dimension. The floor should be properly cured for at least a week before being used, and the supporting floor form should not be removed for at least three weeks.

Materials

Walls, 3 feet deep by 8 inches wide

Concrete, 90 cu. ft.

Mixture, 1:2 $\frac{1}{2}$:4

Lehigh Cement.....18 sacks

Sand, $\frac{1}{4}$ inch and under..... 1 $\frac{3}{4}$ cu. yds.

Stone, $\frac{1}{4}$ inch to 2 inches.... 2 $\frac{3}{4}$ cu. yds.

Floor, 10 feet x 17 feet x 4 inches

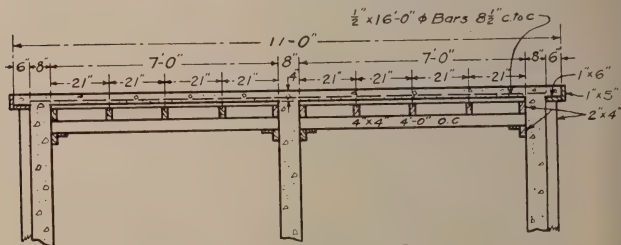
Concrete, 56 $\frac{2}{3}$ cu. ft.

Mixture, 1:2:3

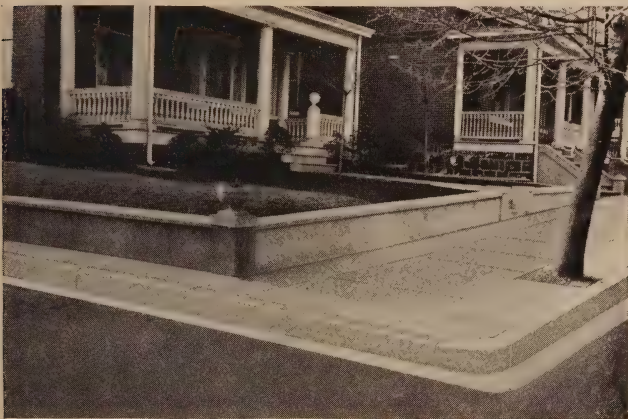
Lehigh Cement.....14 sacks

Sand, $\frac{1}{4}$ inch and under..... 1 $\frac{1}{10}$ cu. yds.

Stone, $\frac{1}{4}$ inch to 1 inch..... 1 $\frac{3}{8}$ cu. yds.



Cross-section of porch floor



Parapet and Retaining Wall

THE use of concrete has in this case proved the simplest means of arranging the grounds in an attractive manner and makes easy the maintenance of the property. The retaining wall brings the lawn to a level where it is easily trimmed, and the precast concrete urn at the corner adds a great deal to the appearance of the property.

This wall, built at reasonable cost, will last indefinitely. It will require no yearly outlay for repairs, it will not crack, rot, or deteriorate, but will strengthen with age.

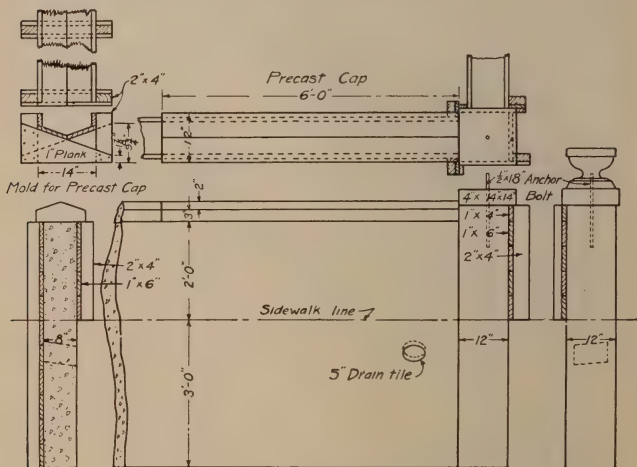
Method

Forms for the wall and post forms must be very carefully set for line and plumb—any deviation will be very noticeable in the finished work. At intervals along the wall drain tile should be provided to carry off ground water which will settle behind the wall and perhaps do some damage if not removed. It is a good

plan to run a line of tile along the inside wall leading into these offtakes, thereby insuring, at little cost, against injury to the wall. Forms should be of tongued and grooved spruce, if possible, to prevent leakage and the resulting rock pockets in the concrete.

In a wall of the height shown in this illustration steel reinforcement will not be needed. Higher walls, however, should be designed by a competent engineer who will place the steel rods to assist the concrete to carry the immense load bearing upon it.

Concrete for the wall proper should be mixed in proportions of $1:2\frac{1}{2}:4$, being 1 part portland cement, $2\frac{1}{2}$ parts of sand, and 4 parts of stone or gravel, graded in size from $\frac{1}{4}$ inch to $1\frac{1}{2}$ inches. It should be placed in layers of about six inches and well spaded to insure consolidation of aggregates.



Details of wall

When the wall has been poured to the proper height, dowels should be placed upon which the precast cap will later be set. A long dowel must be set in the corner post in order to anchor the precast urn in place.

Forms should not be removed for at least three days, at which time the surface of the concrete may be rubbed with an abrasive stone if it is proposed to apply no decorative coat. This will remove the form marks.

In the sketch on the opposite page a form is shown for making the precast cap; however, better results will probably be obtained if the work is given to the local concrete products manufacturer, who is expert in the making of such things. This cap should be made of concrete mixed in proportions of 1:2:3, which is 1 part portland cement, 2 parts of sand, and 3 parts of gravel or stone, and reinforced with three steel rods $\frac{3}{8}$ inch in diameter, spaced evenly across the base of the cap, one inch up from the base, and running lengthwise. These will serve to bridge over any inequalities in the wall and successfully resist any normal strain that they may be subjected to.

When placing the cap on the wall it should be set over dowels previously anchored into the wall concrete, and bonded to the wall by a layer of 1:3 portland cement mortar, which is 1 part portland cement to 3 parts of sand.

The precast concrete urn or flower-pot may be purchased from most concrete products manufacturers ready to set in place. These are deservedly popular because of their attractive appearance and permanence.

Materials

50 feet of wall

Mixture, 1:2½:4

Concrete, 167 cu. ft.

Lehigh Cement.....33 sacks

Sand, ¼ inch and under..... 3½ cu. yds.

Stone, ¼ inch to ½ inch..... 5 cu. yds.

One 6-foot precast cap

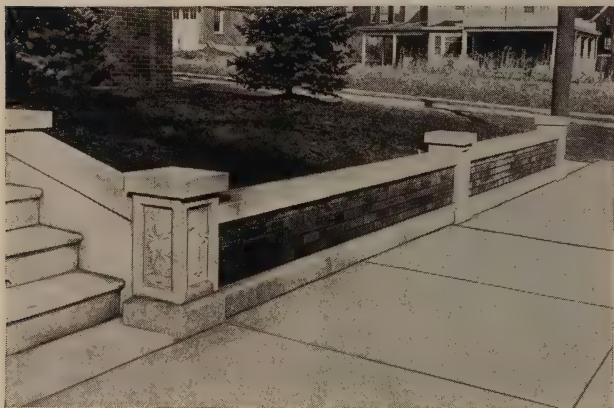
Mixture, 1:2:3

Concrete, 2 cu. ft.

Lehigh Cement..... $\frac{2}{5}$ sack

Sand, ¼ inch and under..... $\frac{1}{30}$ cu. yd.

Stone, ¼ inch to ¾ inch..... $\frac{1}{20}$ cu. yd.



A paneled parapet

A very attractive parapet can be made by using a single course of red concrete brick as a panel.



Low Lawn Parapet

THE use of a concrete parapet wall adds greatly to the appearance of a lawn and eliminates the necessity of a terrace, which is so difficult to care for and which is constantly walked on by passing pedestrians. A low wall, even though it is a simple matter to step over it, serves as a real barrier and assists greatly in keeping the lawn from being trampled upon.

Method

Forms should be very carefully lined and braced, as any weaving or deviation will be very noticeable in the finished work. End posts should be poured monolithic with the parapet.

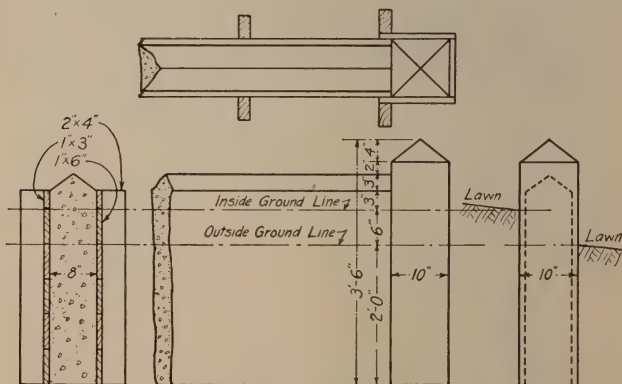
The concrete should be mixed in proportions of $1:2\frac{1}{2}:4$, being 1 part portland cement, $2\frac{1}{2}$ parts of sand, and 4 parts of stone or gravel graded in size from $\frac{1}{4}$ inch to $1\frac{1}{2}$ inches. The forms should be

filled in layers of about six inches each, and when the top of the straight wall is reached, a batch of very stiff or dry concrete is used to shape the peak, as shown in the picture on the preceding page; a string stretched the length of the form will serve as a guide while this finishing is being done.

Upon removal of forms the surface can be rubbed and this will remove the rough edges at the top. Troweling is not recommended, as it will invariably bring too much cement to the surface and upon hardening a thin skin coat will form and later craze or crack.

Materials

Mixture 1 : 2½ : 4	50 Feet of Wall	One Corner Post
Cubic feet of concrete.....	92	1
Sacks of Lehigh Cement.....	18½ sacks	½ sack
Sand, ¼ inch and under.....	1¾ cu. yds.	⅓ cu. yd.
Stone, ¼ inch to 1½ inches.....	2¾ cu. yds.	½ cu. yd.



Small retaining wall



Garage Entrance

MADE of materials that will resist the action of the elements and improve with age. Once built, it stands ready for constant service with no further expense for upkeep or maintenance.

Method

The forms being set, concrete mixed in proportions of $1:2\frac{1}{2}:4$, being 1 part of portland cement, $2\frac{1}{2}$ parts of sand, and 4 parts of stone or gravel, graded

in size from $\frac{1}{4}$ inch to $1\frac{1}{2}$ inches, is placed. In depositing concrete on grades, such as shown in the picture, it is best to start from the lower end; by so doing there is not the possibility of hollow spots developing, as would be the case starting at the up-hill end.

A straight screed is used on the top of the side forms, to bring the concrete to the proper level, and later it is finished with a wood float only. Expansion joints of asphaltic material should be used every 30 feet, and in any case against the curb or sidewalk and at the door-sill of the garage.

The strength, life, and appearance of the driveway depend in a great measure on the curing or hardening of the concrete. After the surface has been finished and has been laid for about four hours, it should be covered with earth about 2 or 3 inches deep, care being taken to use no large stones. This covering should be kept wet for ten days, after which it may be removed and the driveway is then ready for use.

Materials

30 foot driveway, 6 inches thick

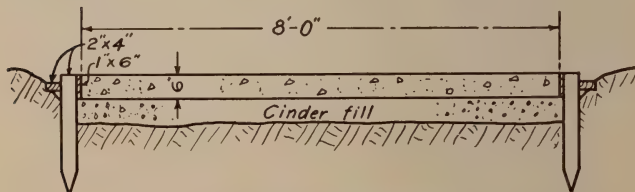
120 cu. ft. of concrete

Mixture, 1: $2\frac{1}{2}$: 4

Lehigh Cement.....24 sacks

Sand, $\frac{1}{4}$ inch and under..... $2\frac{1}{4}$ cu. yds.

Stone, $\frac{1}{4}$ inch to 2 inches..... $3\frac{2}{3}$ cu. yds.



Cross-section of garage entrance



Garage Entrance

THIS type of entrance is meeting with great favor throughout the country. It has many advantages, inasmuch as it provides the safety and permanence of the full-width driveway with approximately half the concrete and permits the use of an attractive strip of lawn between the two concrete runways. The greatest point in its favor, however, is the fact that oil, dropping as it will from the crankcase, will not strike the concrete and cause the unsightly black smudge so frequently seen on the full-width drives and entrances.

Method

Forms should be carefully lined before placing the concrete, as any deviation will be very noticeable in the finished work. The cinder subgrade if used should be thoroughly tamped in place.

Concrete should be mixed in the proportion of 1:2½:4, using stone up to 1½ inches in size. Construction joints should be installed at regular intervals not to exceed eight feet in each runway, and an expansion joint should be placed ⅜ inch or ½ inch in thickness, not over twenty-five feet apart. This is usually done by setting a board the required thickness at the construction joint with the plate, which is removed as soon as the concrete is set enough to permit. This is later poured with hot bitumen, which seals the joint. The concrete should be finished rough with a wood float only, and should be properly cured for at least a week before being used.

Materials

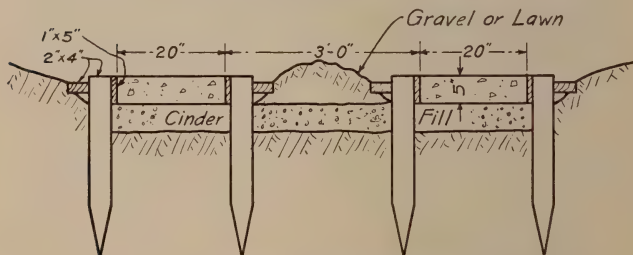
For 20 feet of double track runway

Mixture, 1:2½:4

Lehigh Cement. 6 sacks

Sand, ¼ inch and under. ½ cu. yd.

Stone ¼ inch to 1½ inches. ⅔ cu. yd.



Cross-section of garage runway

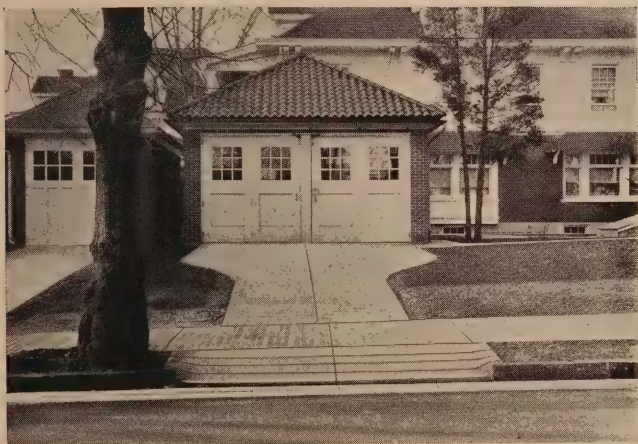


Garage Driveway

THE owner selected concrete to insure entrance at all times of the year. This pavement has been giving service for many years and has not required a penny's worth of labor in maintaining its pleasing appearance and service. Once in, the owner forgets it except in rainy weather, when he congratulates himself for having selected concrete, the most rigid and permanent of materials.

Method

Build the curbing first, and when the forms are removed, draw a line indicating the top of the driveway on each curb. This line will serve as a guide in keeping the concrete to grade. Because of the vary-



Two-Car Garage Driveway

AN entrance wide enough for a single car, widened at the garage to permit entering either door, conserves space and is economical to build. Such a treatment provides the utmost in service and satisfaction and requires no attention in later years.

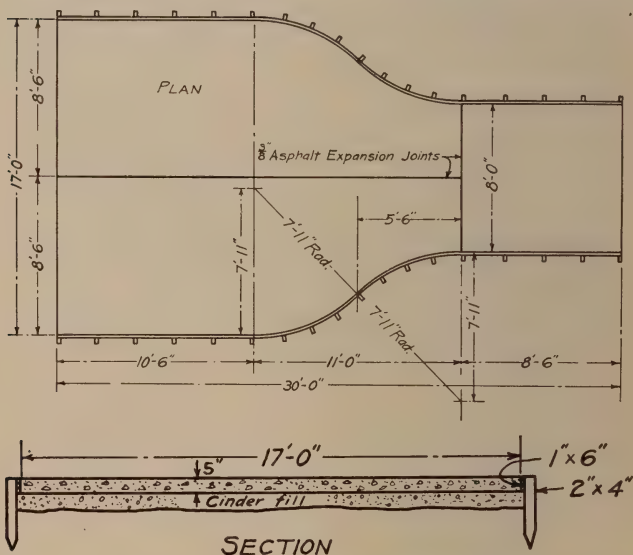
Method

In setting the forms around the reverse curve make shallow saw-cuts about a foot apart in the back of the one inch side form lumber. This will make it much easier to bend the form to the exact measurements required. Set a straight form on the center line of the wide section, and use this and the outside form as a level to which the concrete is screeded with a straight edge. To attempt to surface the entire width at one time would be apt to develop hollows in the pavement which will be very noticeable, especially after a rain.

The concrete should be mixed in proportions of 1:2½:4, being 1 part of portland cement, 2½ parts of sand, and 4 parts of stone or gravel, graded from ¼ inch to 1½ inches in size.

Before pouring the second half of the wide section the form must be removed and a ⅜-inch asphaltic expansion joint be substituted; also an expansion joint should be used at the beginning of the approach, and at thirty-foot intervals over the entire distance to the curb or sidewalk.

If the concrete is still somewhat soft or green in the first half when the second half is laid, it is well to lay a plank on it and correct the straight edge accordingly when finishing the surface of the second half.



Plan and cross-section of two-car garage driveway

The finish is made with a wood float only. Curing should take ten days or two weeks, after which the pavement is ready for use.

Materials

Mixture, 1:2 $\frac{1}{2}$:4

Entrance

Concrete.....	5 cu. yds.
Lehigh Cement.....	27 sacks
Sand.....	2 $\frac{3}{5}$ cu. yds.
Stone.....	4 cu. yds.

Approach, 30 feet long

Concrete.....	3 $\frac{3}{4}$ cu. yds.
Lehigh Cement.....	20 sacks
Sand.....	2 cu. yds.
Stone.....	3 cu. yds.



A concrete driveway on a steep grade will not wash out, and provides entrance in all weather



Garage with Concrete Floor

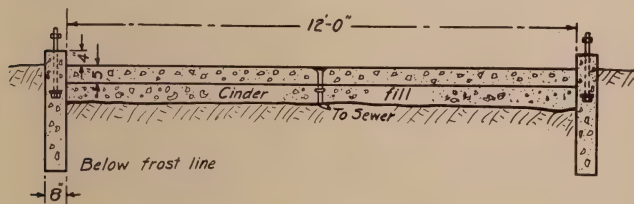
BUILT of concrete or concrete masonry units, a garage will meet the requirements of the most strict and exacting building codes. Garages must be fire-proof, and concrete has proved itself.

Method of Constructing Foundation and Floor

The foundation and footings should extend below the normal frost line, and should be built of concrete mixed in proportions of $1:2\frac{1}{2}:4$, being 1 part of portland cement, $2\frac{1}{2}$ parts of sand, and 4 parts of stone or gravel, graded in size from $\frac{1}{4}$ inch to $1\frac{1}{2}$ inches. Spread footings should be used, except in soil that is very firm.

After the inside foundation forms have been removed, the earth subgrade should be well tamped, and if it is earth that will not permit proper drainage of water, it is well to use a layer of cinders or gravel directly beneath the concrete floor.

The floor concrete should be mixed in proportions



of 1:2:3 $\frac{1}{2}$, using stone not larger than one inch. This should be thoroughly mixed, using as little water as possible. The surface should be finished with a wood float and should be sloped to a drain.

If it is proposed to erect a frame structure upon the concrete foundation, bolts should be set in the wall with which to anchor the timber plate in place.

Materials

Foundations, 3 feet deep, no footings

Mixture, 1:2 $\frac{1}{2}$:4

Concrete, 133 $\frac{1}{3}$ cu. ft.

Lehigh Cement.....27 sacks

Sand, $\frac{1}{4}$ inch and under.....2 $\frac{1}{2}$ cu. yds.

Stone, $\frac{1}{4}$ inch to 1 $\frac{1}{2}$ inches...4 cu. yds.

Floor, 20 feet x 12 feet x 5 inches

Mixture, 1:2:3 $\frac{1}{2}$

Concrete, 100 cu. ft.

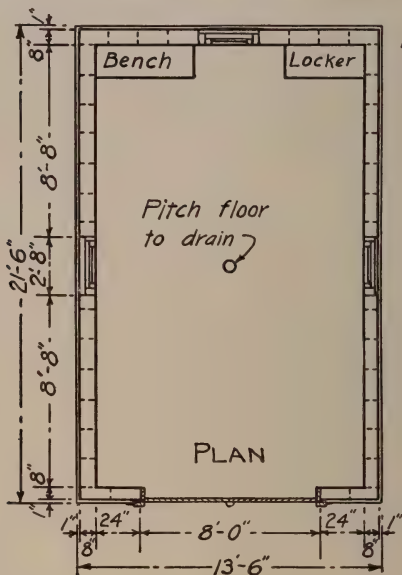
Lehigh Cement.....24 sacks

Sand, $\frac{1}{4}$ inch and under.....1 $\frac{3}{4}$ cu. yds.

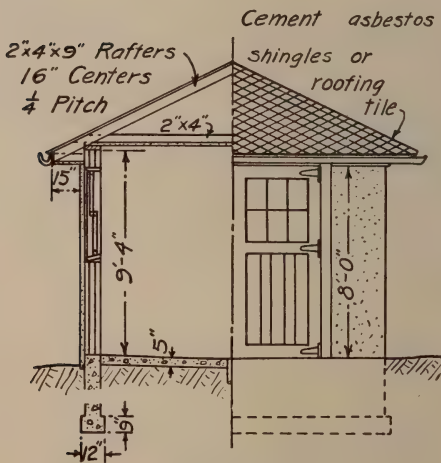
Stone, $\frac{1}{4}$ inch to 1 inch.....3 cu. yds.

When the foundation is completed, work on the superstructure may proceed at once. In fact, this is to be preferred, as it will serve to protect the floor concrete from the heat of the sun while it is curing, and keep off rain, which will mark up the surface of fresh concrete and wash away the cement.

Rough-faced concrete blocks 8 x 8 x 16 are used



NOTE:
Windows
2 Lt. 24"x20"



Section elevation



One-car garage with concrete driveway

in this plan, and are laid in Portland cement mortar mixed in proportions of 1:3, being 1 part portland cement and 3 parts sand.

The roof structure is of frame construction, the bed plate is anchored to the concrete blocks by bolts set in concrete poured into the cores of the top course of blocks.

Portland cement stucco mixed in proportions of 1:3, and colored to harmonize with its surroundings, will make the garage a source of pride and a distinctive addition to the property.

Materials

Garage superstructure

8 x 8 x 16 concrete block.....516

8 x 8 x 8 concrete block.....42

Sand, $\frac{1}{4}$ inch and under..... $2\frac{2}{3}$ cu. yds.

Lehigh Cement.....24 sacks

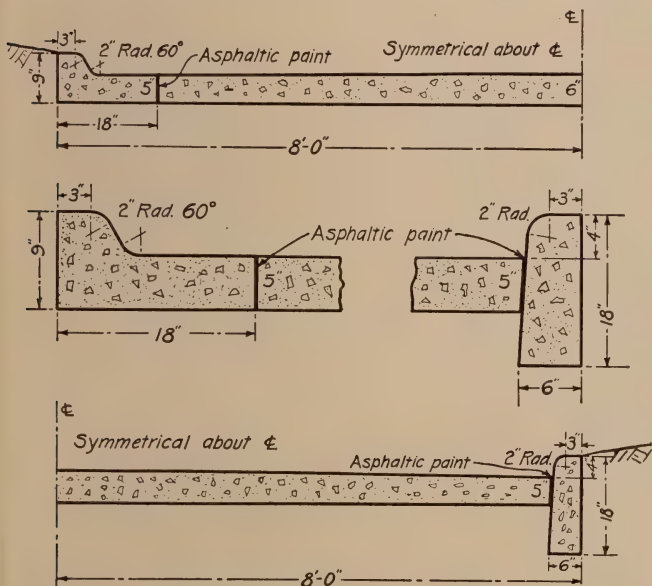


Private Drive

THE value of concrete as a road material need not be discussed at length here. It is seen everywhere. Every State in the Union has concrete highways or streets, and many of them have adopted concrete to the exclusion of all other materials for the building of permanent roads. Every one likes to drive on concrete because of its smooth riding qualities, its non-skid surface, and its pleasing appearance. Roads built of concrete are never closed by inclement weather. They are quickly and economically built with local labor and materials, are kept in a sanitary and serviceable condition with a minimum of expense, and will last indefinitely.

Method

The road shown in the accompanying sketch was designed and built for light traffic, and the integral curb and gutter, described elsewhere in this book, was used. The use of the integral type of curb and gutter shortens the span of the road slab, which is an



advantage and permits the construction of the curb first. This is later used in place of a side form, from which the screed is operated to strike off the surface of the pavement.

In using the separate curb it may either be built first and an offset screed used for the pavement, or it may be built after the pavement has been laid. The first-mentioned method is usually adopted.

The concrete should be machine mixed to insure accuracy, and in the proportions of 1:2:4, being 1 part of portland cement, 2 parts of sand, and 4 parts of stone or gravel, graded in size from $\frac{1}{4}$ inch to 2 inches. Use as little water as possible to obtain a workable mix.

Three-eighths-inch expansion joints of asphalt or tar should be provided on each side of the road slab, regardless of the type of curb. Transverse expansion joints should be installed every fifty feet and at the end of the day's work. Care must be taken to set these joints at right angles to the road surface.

These joints are usually made with the aid of a $\frac{3}{16}$ inch or $\frac{1}{4}$ inch thick piece of steel shaped to conform to the cross-section of the road. This is held in place and plumbed by pins or stakes driven securely into the subgrade. On the side opposite to the pins the joint filler is placed. Concrete is deposited on both sides of this plate, which is then removed together with the pins, leaving the filler in place.

The pavement shown is not reinforced, nor is it considered necessary for pavements subjected to light traffic only. However, on work of this nature circumferential reinforcing, consisting of a single $\frac{5}{8}$ -inch steel rod, may well be used placed 2 inches down from the top of the slab, and located 4 inches in from the edges, both longitudinal and transverse of each slab. The use of such reinforcement will effectually prevent cracking of the pavement at the edges, and especially at the corners.

Integral curbs are usually doweled to the road slab with two-foot iron pins spaced four feet apart. This is done to prevent the widening of the joint and to prevent seepage.

The surface should be finished with a wood float only, and should be cured by the use of two or three inches of earth kept wet for at least eighteen days. At the end of the curing period the layer of earth is removed and the pavement is then ready for use.

Materials

50 feet of 15-foot roadway

Mixture, 1:2:4

Concrete, $13\frac{3}{4}$ cu. yds.

Lehigh Cement..... 82 sacks

Sand, $\frac{1}{4}$ inch and under..... $6\frac{1}{4}$ cu. yds.

Stone, $\frac{1}{4}$ inch to 2 inches.... $12\frac{1}{2}$ cu. yds.

100 feet of curbing (separate)

Mixture, 1:2:4

Concrete, $2\frac{3}{4}$ cu. yds.

Lehigh Cement..... 16 sacks

Sand, $\frac{1}{4}$ inch and under..... $1\frac{1}{4}$ cu. yds.

Stone, $\frac{1}{4}$ inch to 2 inches.... $2\frac{1}{2}$ cu. yds.

The picture below shows a somewhat different arrangement and demonstrates effectively the possibilities of concrete in the adornment of suburban property. Such a treatment provides a small community parking space as well as an attractive sanitary permanent drive in all weather.



A combination garage entrance and turnstile



Sidewalk, Curb, and Gutter

THIS work can be profitably done at one time, and when finished, it is but another step to the paving of the street itself, and the abutting property owners have no further trouble from dust or mud.

Concrete curbing is used extensively in practically all cities and towns throughout the country. It has been found most satisfactory and far more economical than any other suitable material.

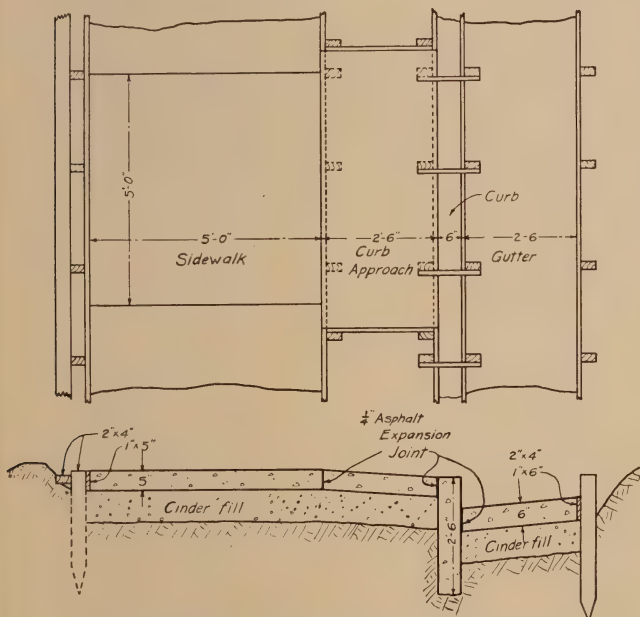
The concrete gutter is but a part of the concrete street which every one desires and enjoys. The concrete sidewalk has long been accepted as the best type possible, due to its ability to resist wear and its slip-proof qualities.

Method

The forms for the sidewalk and curb are set together and the placing of the concrete in both is done

at the same time. The curb approaches and the gutter cannot be poured until the forms have been removed from the concrete in the sidewalk and curb.

Construction joints should be provided in the sidewalk every five feet, making five-foot squares; in the gutter they should be spaced not more than ten feet apart. One-quarter inch expansion joints should occur in the sidewalk every twenty-five feet; in the gutter every twenty feet, and in the curb every fifty feet. Expansion joints should be placed at one end of the curb approach slab and should separate the curb from the gutter. This will prevent the curb from tipping.



Plan and cross-section of sidewalk, curb, and gutter



The concrete should be mixed in proportions of $1:2\frac{1}{2}:4$, being 1 part portland cement, $2\frac{1}{2}$ parts of sand, and 4 parts of stone or gravel, graded in size from $\frac{1}{4}$ inch to 1 inch. The surface of the walk, curb approach, and gutter should be finished with a wood float only. An edging tool should be used to round the curb edges. The curb can be rubbed with an abrasive stone to remove form marks and improve its appearance. Curing should take at least a week for sidewalk, curb approach and curb, and two weeks for the gutter.

Materials

Mixture, $1:2\frac{1}{2}:4$

	Length	Width	Thick- ness	Cu. Ft. Con- crete	Sacks, Lehigh Ce- ment	Cu. Yds. Sand Under $\frac{1}{4}$ in.	Cu. Yds. Stone $\frac{1}{4}$ in. to 1 in.
Sidewalk.....	20' 0"	5' 0"	0' 5"	42	9	$\frac{4}{5}$	$1\frac{1}{4}$
Curb Approach	2' 6"	6' 0"	0' 5"	$7\frac{1}{2}$	$11\frac{1}{2}$	$\frac{1}{8}$	$\frac{1}{5}$
Curb.....	50' 0"	0' 6"	2' 6"	$62\frac{1}{2}$	12	$1\frac{1}{5}$	$1\frac{9}{10}$
Gutter.....	20' 0"	2' 6"	0' 6"	25	5	$\frac{1}{2}$	$\frac{3}{4}$



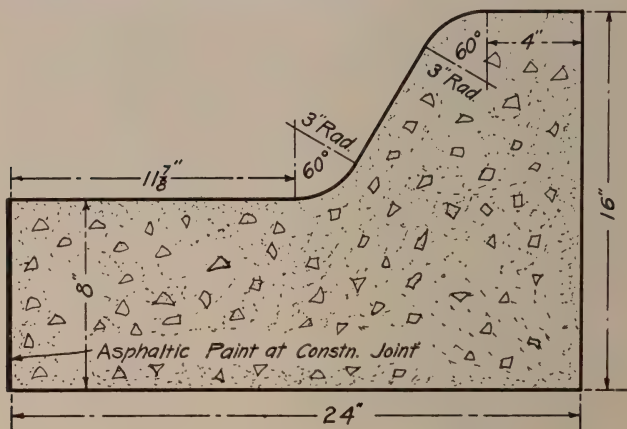
Integral Curb and Gutter

THIS type of construction is meeting with great favor in all parts of the country, and particularly in residential districts, where its neat and pleasing appearance blends harmoniously with its surroundings. The fact that the face of the curb slopes back proves most satisfactory in that it does not scrape or injure tires of cars parked close to the curb.

Method

Forms are usually used to shape curbs; however, it has often proved advisable to use a very stiff or dry mixture and shape the curb to contour by the use of special forms of screeds and trowels.

Forms are simple to build and set. An opening is left in the top through which the concrete may be deposited and spaded. They should be removed as



soon as the concrete is hard enough, and the surface should be entirely gone over, all holes filled and troweled to give the curb a uniform appearance.

The concrete should be 1:2:3, being 1 part of portland cement, 2 parts of sand, and 4 parts of gravel or stone graded in size from $\frac{1}{4}$ inch to 1 inch.

Expansion joints should be installed in curbing at the location of joints in the pavement, thus presenting a uniform appearance.

Curbs should be cured for at least ten days by being kept wet, in order that the concrete may attain its full strength, and thus withstand the repeated severe shocks to which it will be constantly subjected.

Materials

50 feet of integral curb and gutter

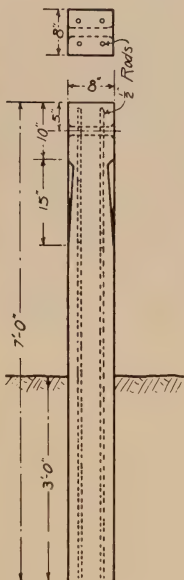
Mixture, 1:2:3

Concrete, 100 cu. ft.

Lehigh Cement 25 sacks

Sand, $\frac{1}{4}$ inch and under $2\frac{1}{4}$ cu. yds.

Stone, $\frac{1}{4}$ inch to 1 inch 3 cu. yds.



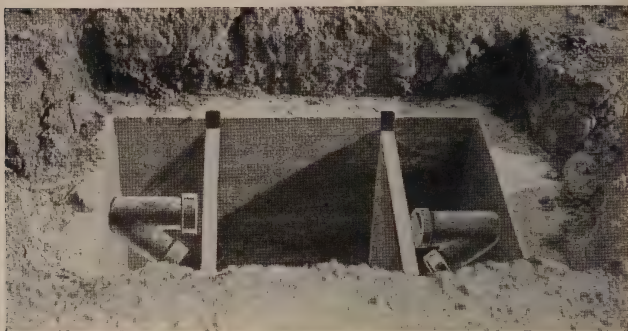
Hitching Post

THIS type of post is usually precast and later set in place and securely anchored by pouring concrete around it.

Forms should be built of white pine, leaving one side open to place the reinforcing and concrete.

The reinforcing rods are set in place as the pouring of the concrete progresses.

The concrete should be mixed in proportions of 1:2:3, being 1 part of portland cement, 2 parts of sand, and 3 parts of stone or gravel graded in size from $\frac{1}{4}$ inch to 1 inch. After the forms are off the concrete should be rubbed to remove all traces of form marks. The post should not be set up for at least two weeks.



Septic Tank

THE sanitary requirements of the modern home are very ably cared for by the concrete septic tank. Many cities and towns are still without sewerage facilities, and the septic tank has been approved as the most sanitary and satisfactory method of sewage disposal. In farming districts the septic tank is universally accepted, it having proved itself efficient in its work, easily and quickly constructed, and low in first cost and maintenance.

Method

A septic tank is a watertight compartment through which a slow current of sewage passes. While passing through it is worked on by bacteria and most of the solids are turned into liquids and gas.

The accompanying plans and sketches are self-explanatory. They indicate method for determining the location of the intake and outlet, and the placing of the baffleboards in slots cut into the concrete walls.

Exterior forms are not necessary in soils that are

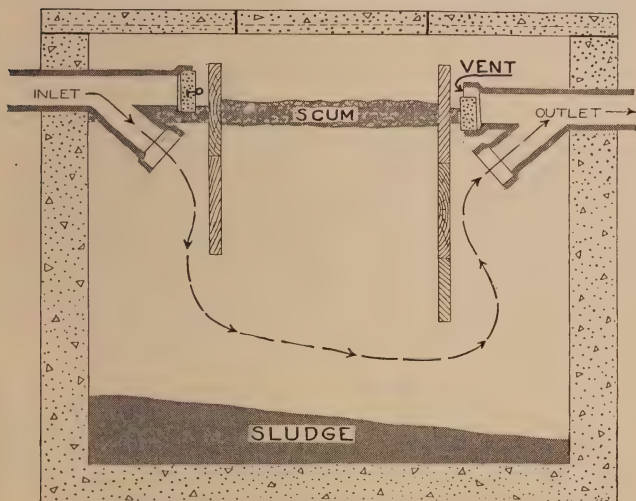


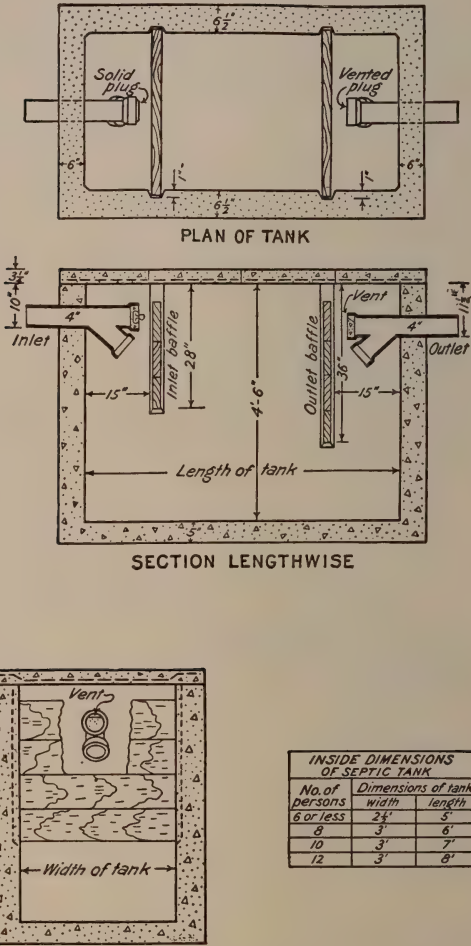
Fig. 1.—Section of tank in operation

firm. The walls should be at least six inches thick, of 1:2:4 concrete, being 1 part of portland cement, 2 parts of sand, and 4 parts of gravel or stone, graded in size from $\frac{1}{4}$ inch to $1\frac{1}{2}$ inches. "Plums" or large stones should not be used, as they are apt to cause leakage in the walls.

The cover is divided into three sections—one form can be made to serve by using it three times. Each cover slab should be reinforced with galvanized expanded metal lath placed $\frac{3}{4}$ inch from the bottom of the concrete. Reinforcing is not necessary in the walls.

The floor should be poured first. This gives an excellent footing for setting the wall forms.

The forms should not be removed until the con-



INSIDE DIMENSIONS OF SEPTIC TANK		
No. of persons	Dimensions of tank	
	width	length
6 or less	2 1/2'	5'
8	3'	6'
10	3'	7'
12	3'	8'

Fig. 2.—Detailed drawings of tank

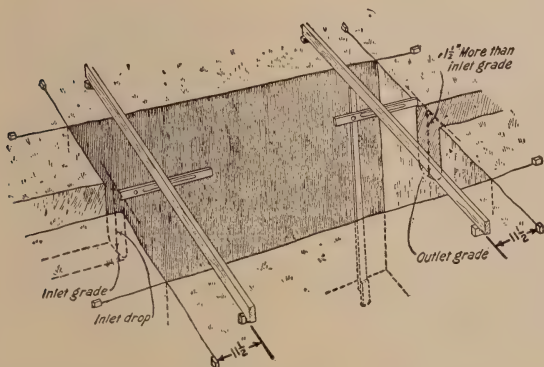


Fig. 3.—Showing method of locating inlet and outlet grades with a level held against the bottom of the cross-pieces. Stick to measure depth of excavation is also shown. The 5-inch addition at the bottom can be removed and the stick used as a guide in laying the concrete floor

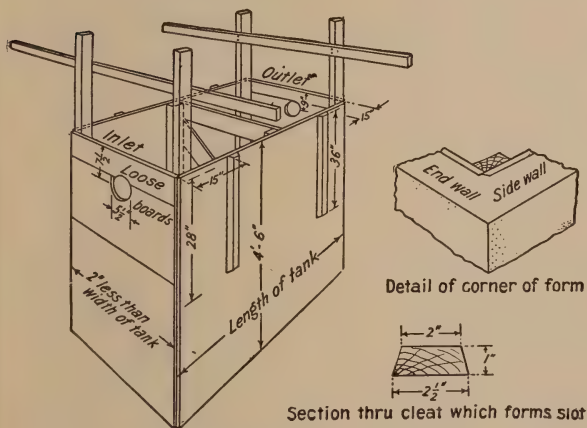


Fig. 4.—Form for building tank

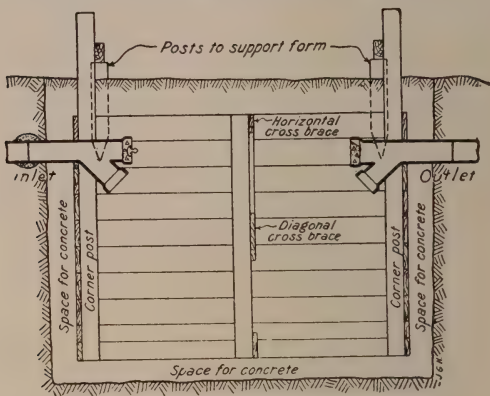


Fig. 5.—Form in place

crete has thoroughly hardened. This will probably take about a week.

Materials

For tank. Mixture, 1:2:4

Inside dimensions, $2\frac{1}{2}$ feet x 5 feet x $4\frac{1}{2}$ feet

Concrete, $48\frac{1}{4}$ cu. ft.

Lehigh Cement..... $10\frac{1}{2}$ sacks

Sand, $\frac{1}{4}$ inch and under..... $\frac{4}{5}$ cu. yd.

Gravel, $\frac{1}{4}$ inch to $1\frac{1}{2}$ inches. $1\frac{3}{5}$ cu. yd.

For cover. Mixture, 1:2:3

Concrete, $5\frac{1}{4}$ cu. ft.

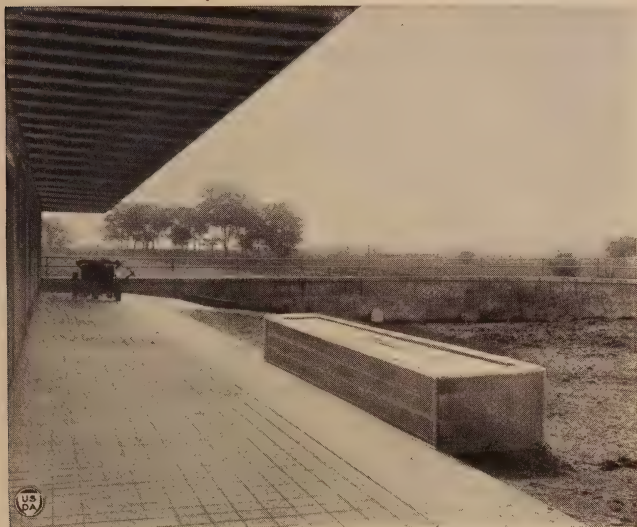
Lehigh Cement..... $11\frac{1}{2}$ sacks

Sand, $\frac{1}{4}$ inch and under..... $\frac{1}{20}$ cu. yd.

Gravel, $\frac{1}{4}$ inch to $\frac{3}{4}$ inch..... $\frac{1}{7}$ cu. yd.



Fig. 6.—Absorption tile laid in trench with tar paper over joints, surrounded with gravel and the top soil placed directly above the tile



Watering Troughs

THE permanence of concrete is an essential in its use for watering troughs. Other materials may rot, rust and deteriorate, but concrete subjected to constant moisture continues to strengthen indefinitely. A watering trough of concrete is clean and sanitary, the concrete does not in any way affect the water or its taste, and it will last indefinitely without further expenditures for upkeep.

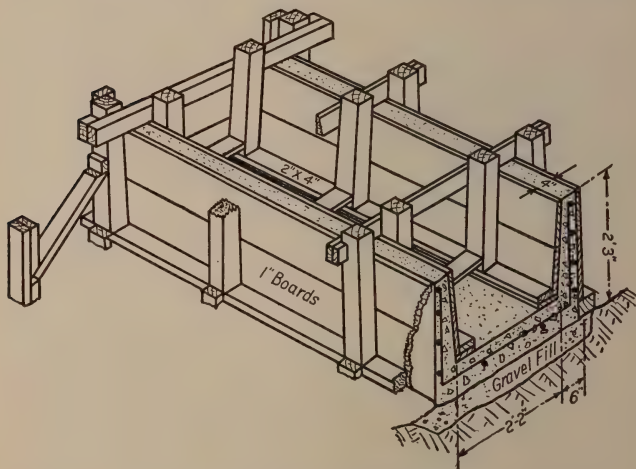
Method

Construct forms of tongued and grooved spruce lumber if possible, set them carefully, and hang the inside from cross-pieces attached to the outside form. By placing one board about four inches wide on the inside form at the top floor line, the entire trough

can be poured in one operation, footings and all, making the structure monolithic throughout, and eliminating the possibility of leaky seams. This board is necessary to prevent the fresh concrete in the wall from bubbling under the form into the trough interior.

The concrete should be mixed in proportions of 1:2:3, being 1 part of portland cement, 2 parts of sand, and 3 parts of stone and gravel, graded in size from $\frac{1}{4}$ inch to 1 inch. This should be poured in layers of about six inches and mixed as dry as possible. Machine mixing is preferred, as the concrete can then be thoroughly mixed to the proper consistency with a minimum of water content.

The concrete should be thoroughly spaded to consolidate the aggregate and insure a close bond with the reinforcing steel, which is installed prior to the



Plan of small watering trough

pouring of the concrete. These bars should be securely wired at each intersection and held in place.

The use of cross wires from the inside to the outside form is not recommended, because they cannot be removed and they eventually will rust out and leakage will then occur. Spreaders may be used between the inner and outer forms to prevent any shifting, but they must be removed as the concrete rises.

The floor of the trough should be finished with a steel trowel immediately and the forms should be removed from the inside as soon as the concrete is hard enough, and any air holes or rock pockets immediately filled and troweled smooth. A thin plaster coat of 1:2 mortar will make a good bond with the wall concrete, and present an impervious surface, through which water cannot pass. This should be finished smooth with a steel trowel.

Materials

Trough, 3 feet 6 inches x 8 feet x 1 foot x 9 inches

Mixture, 1:2:3

Concrete, 24 cu. ft.

Lehigh Cement.....6 sacks

Sand, $\frac{1}{4}$ inch and under..... $\frac{1}{2}$ cu. yd.

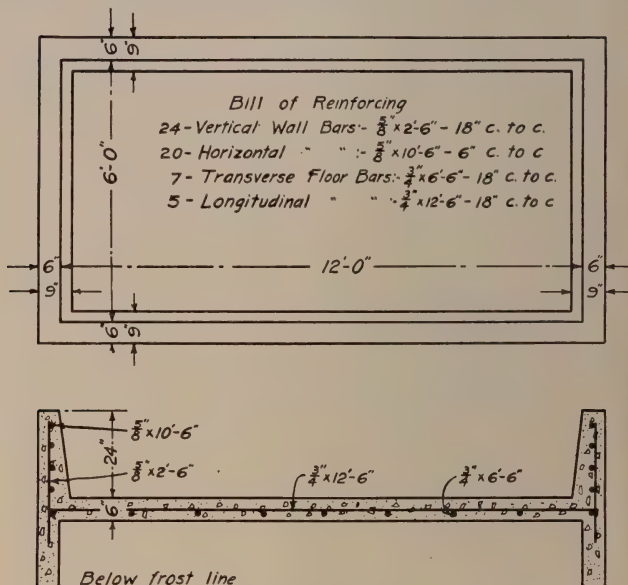
Stone, $\frac{1}{4}$ inch to 1 inch..... $\frac{2}{3}$ cu. yd.

$\frac{5}{8}$ inch rods—7 feet 6 inches long 10 pieces

$\frac{5}{8}$ inch rods—6 feet 2 inches long 8 pieces

In building the large watering trough the same methods and mixtures should be used as those described for the construction of the smaller trough.

The list of reinforcing material is shown on the plan. The twenty horizontal wall rods should be bent to carry around the corners, lapping a foot at the center of the ends and sides. The bars should



Plan and cross-section of watering trough

be securely wired together at the lap. The vertical wall rods are set into the footing concrete at least six inches. If the footings are poured before the wall forms are set, these rods should be placed and they then make easy the setting of the balance of the reinforcing, which may be wired to them.

Materials

Mixture, 1:2:3

Concrete, 139.5 cu. ft.

Lehigh Cement.....35 sacks

Sand, $\frac{1}{4}$ inch and under..... $2\frac{7}{10}$ cu. yds.

Stone, $\frac{1}{4}$ inch to 1 inch..... 4 cu. yds.

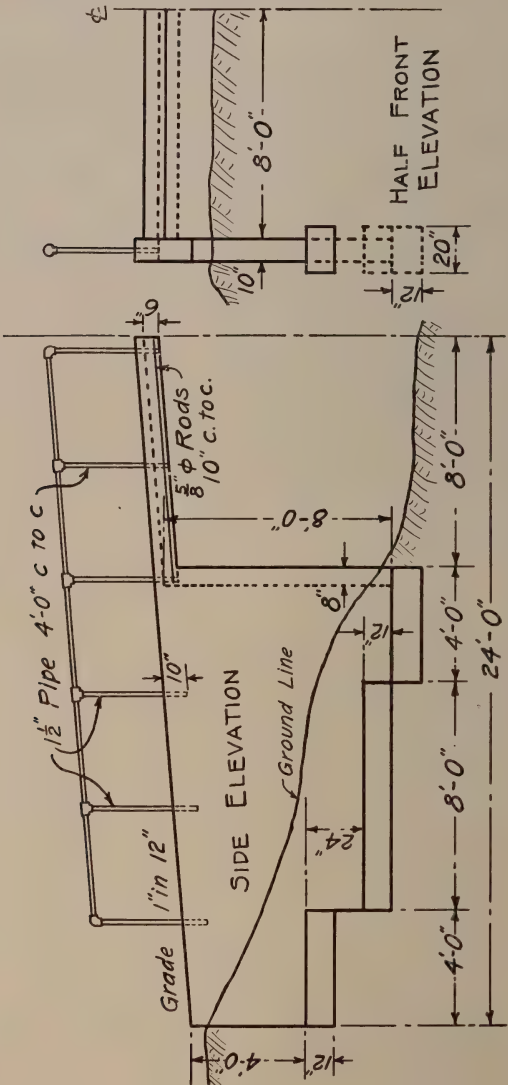


Barn Approach

A SUBSTANTIAL approach is a worthwhile improvement to a barn, because it keeps the soil in place during heavy rains, and the concrete walls always present a neat and attractive appearance.

Method

Forms should be constructed of one-inch boards and two by four studs spaced not over 18 inches apart, and set on spread footings previously poured of concrete mixed in proportions of $1:2\frac{1}{2}:5$. The wall concrete should be mixed in proportions of $1:2\frac{1}{2}:4$, and the suspended slab should be of $1:2:3$ concrete, with $\frac{5}{8}$ inch bars spaced 10 inches center to center, and $1\frac{1}{2}$ inches from the bottom of the slab. This is for an eight-foot span only—other spans should be computed by an engineer.



Side elevation of barn approach

When the wall concrete is poured, the $1\frac{1}{2}$ inch galvanized iron pipe are set in place four feet apart. After the concrete has been cured, these posts may be connected with pipe to make a strong railing the length of the approach.

A four-inch curb is provided on the slab. This should be constructed the full width of the wall of the approach, to present a uniform appearance.

In the end wall of the approach one or two openings should be left, four or five inches square, to permit drainage at all times of the earth fill with which the walls are filled.

After the forms are removed ample time should be allowed for the concrete to cure and harden before building up the earth fill roadway.

Materials

24 feet of footing

Mixture, 1:2 $\frac{1}{2}$:5

Concrete, 1 $\frac{1}{2}$ cu. yds.

Lehigh Cement.....9 sacks

Sand, $\frac{1}{4}$ inch and under..... $\frac{2}{3}$ cu. yd.

Stone, $\frac{1}{4}$ inch to 1 $\frac{1}{2}$ inches... 1 $\frac{1}{3}$ cu. yds.

Approach walls

Mixture, 1:2 $\frac{1}{2}$:4

Concrete, 150 cu. ft.

Lehigh Cement.....31 sacks

Sand, $\frac{1}{4}$ inch and under..... 3 cu. yds.

Stone, $\frac{1}{4}$ inch to 1 $\frac{1}{2}$ inches... 4 $\frac{2}{3}$ cu. yds.

Slab, 8 feet x 16 feet x 6 inches

Mixture, 1:2:3

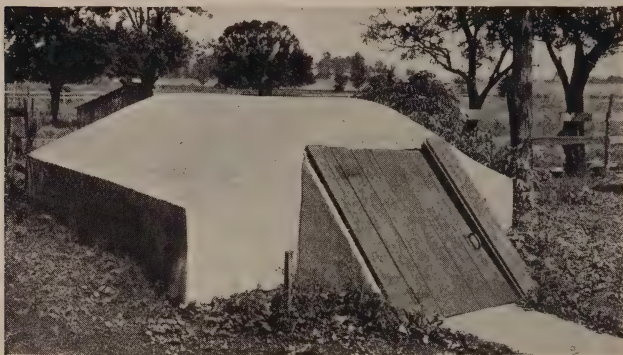
Concrete, 64 cu. ft.

Lehigh Cement.....24 sacks

Sand, $\frac{1}{4}$ inch and under 1 $\frac{1}{4}$ cu. yds.

Stone, $\frac{1}{4}$ inch to 1 inch. 1 $\frac{7}{8}$ cu. yds.

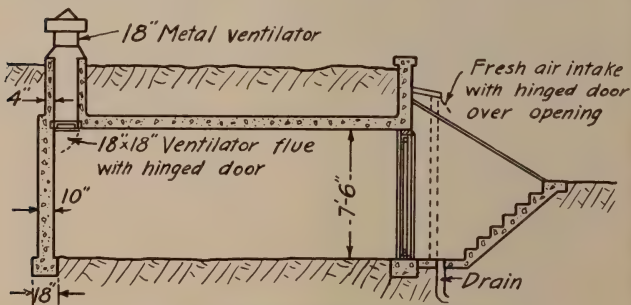
Reinforcement (24 pieces) $\frac{5}{8}$ in. x 8 ft. 6 in.



Storage Cellars

CONCRETE storage cellars have proved their worth in all sections of the country. These plans give details of a storage cellar which was built during 1924 at the Pennsylvania State College.

It has been determined that dirt floors are most satisfactory, and so in this work wall and column footings only were used, they being one foot deep, and of concrete, mixed in proportions of $1:2\frac{1}{2}:4$. Walls and columns are of $1:2:4$.



Cross-section of small storage cellar

For this work a double wall was constructed with a movable form. Concrete building units, block or tile, prove satisfactory for this sort of work. The monolithic concrete wall is also used extensively.

The roof is of concrete mixed 1:2:3, and heavily reinforced with steel bars, a complete schedule of which is given.

A section of a small storage cellar is also shown. This is built of monolithic concrete throughout, the footings and walls being of concrete mixed in proportions of 1:2½:4 and the roof mixed 1:2:3.

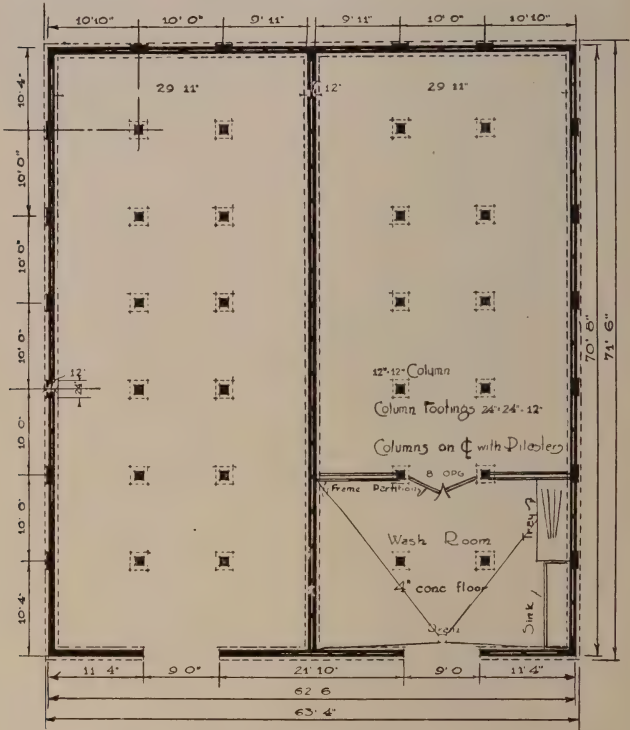
A table giving the necessary reinforcing for roof spans is given, as follows:

REINFORCEMENT REQUIRED ACROSS THE ROOF OF
A STORAGE CELLAR

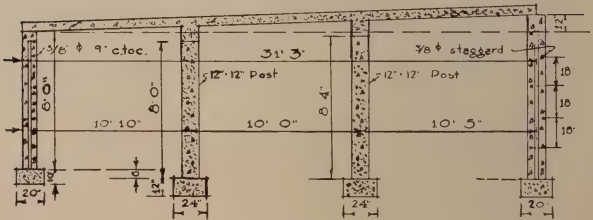
Width of Span	Thickness of Concrete	Size of Bars Needed	Spacing, from Center to Center
8 feet	5 inches	½ inch	6½ inches
9 " "	5½ " "	5/8 " "	9 " "
10 " "	6 " "	5/8 " "	8 " "
11 " "	6½ " "	5/8 " "	7½ " "
12 " "	7½ " "	5/8 " "	6 " "
13 " "	8 " "	¾ " "	8½ " "
14 " "	9 " "	¾ " "	7½ " "
15 " "	9½ " "	¾ " "	7 " "
16 " "	10 " "	7/8 " "	9 " "

The roof should be finished with a slight crown to drain water, and should be troweled smooth with a steel float. The inside walls and roof may be given a coat of portland cement mortar if desired.

The deck or roof forms should be left in place for at least three weeks, and the concrete should be properly cured during that time in order that it may gain its maximum strength.

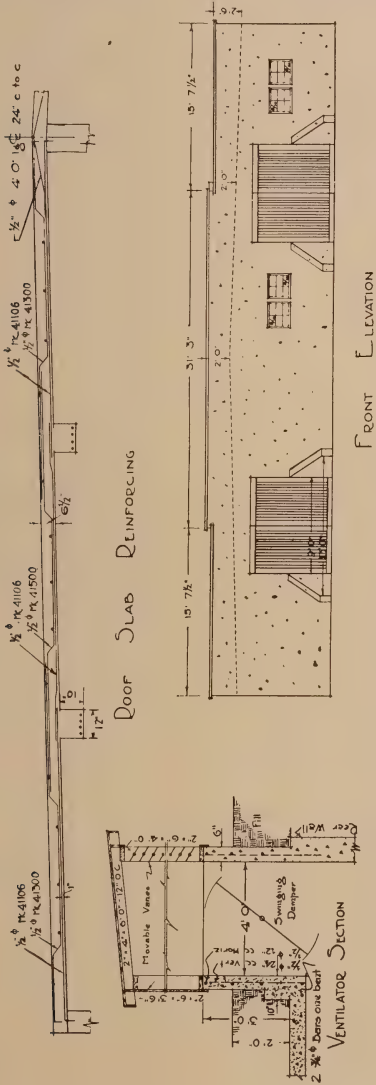


PLAN

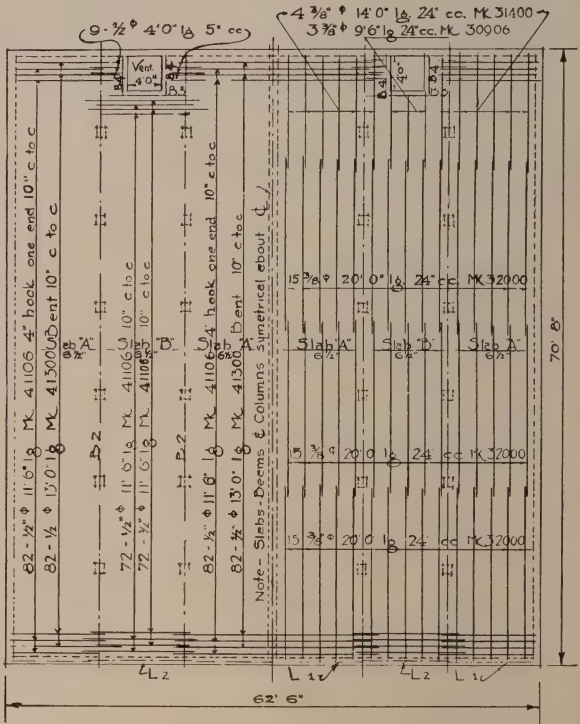


SECTION HALF

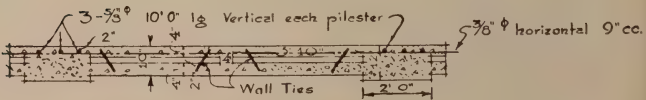
Plan and section storage cellar, built 1924, Pennsylvania State College



Front elevation and roof details, storage cellar built 1924, Pennsylvania State College



ROOF SLAB REINFORCING

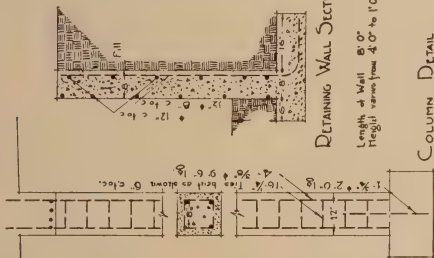


WALL SECTION

Roof slab reinforcing storage cellar, built 1924, Pennsylvania State College

Bill of Material - Steel

NO	SIZE	LENGTH	MARK	REMARKS
56	3/8"	11'-0"	61100	BEAM - D1 & D2
16	3/8"	13'-6"	B1	BEAM - B1
40	3/8"	15'-6"	B2	- D2
2	3/8"	11'-0"	61100	- D3
2	3/8"	11'-0"	D3	- D3
6	5/8"	5'-6"	50506	- D4
4	5/8"	9'-0"	50900	WINDOW
2	3/8"	11'-0"	61100	DOOR
2	3/8"	11'-0"	L2	-
328	5/8"	11'-6"	41106	SLAB - A'
328	5/8"	13'-0"	41300	SLAB - A'
144	1/2"	11'-6"	41106	SLAB - B'
144	1/2"	14'-0"	41400	SLAB - B'
36	1/2"	4'-0"	40400	SLAB - B'
90	3/8"	20'-0"	32000	TEMP BARS SLAB D
16	3/8"	4'-0"	34000	- - A-B
6	1/2"	9'-6"	30006	TEMP BARS SLAB D
30	1/2"	3'-0"	40300	VERT PARAPET WALL
12	1/2"	16'-6"	41606	HORIZ -
24	1/2"	3'-4"	40304	VERT VENTILATOR
6	1/2"	21'-0"	42100	HORIZ -
48	3/8"	10'-0"	51000	VERT PILLASTERS
24	3/8"	2'-0"	60200	FOOTING DOWELS
180	3/8"	70'-0"	52000	HORIZ WALLS
96	3/8"	9'-6"	30006	VERT COLUMNS
304	1/4"	3'-0"	20300	COLUMN TIES
35	1/2"	4'-0"	40400	TOP CENTER WALL
17	1/2"	20'-0"	42000	VERT RET WALLS
72	3/8"	7'-6"	30708	HORIZ -
1600	1/8"	1/2" x 10'	STRAP	WALL TIES

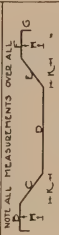


RETAINING WALL SECTION

Length of Wall 8'-0"
Height varies from 4'-0" to 1'-0"

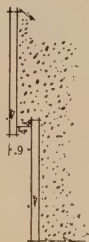
COLUMN DETAIL

BEAM AND SLAB SCHEDULE									
STRAIGHT BARS					BENT BARS				
NO	SIZE	LENGTH	MC	SIZE	NO	SIZE	LENGTH	MC	
BEAMS	MARK	WT/D	NO	SIZE	LENGTH	MC	SIZE	LENGTH	MC
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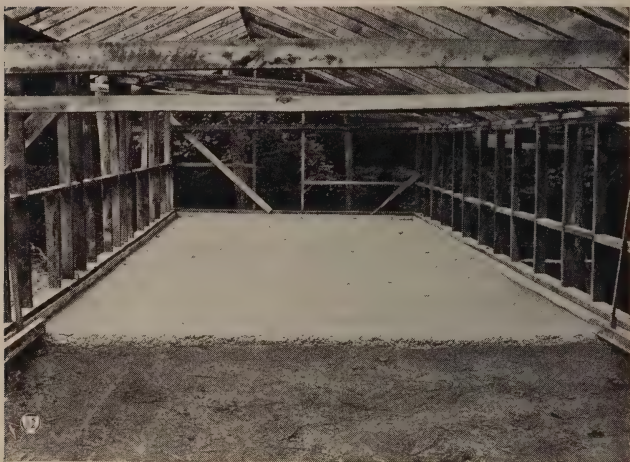
BENDING DIAGRAM

NOTE: ALL MEASUREMENTS OVER ALL



PARAPET WALL DETAILS

Bill of steel required, storage cellar, built 1924, Pennsylvania State College



Poultry House Floor

A GOOD poultry house should provide perfect protection from storms, sufficient sunshine during the winter months, plenty of ventilation without drafts and uniformity of temperature.

A concrete foundation and floor will provide the most sanitary and permanent base at the lowest cost consistent with good construction.

Floors of concrete do not rot or disintegrate. They are rigid and safe to walk upon, they are quickly and easily built with local materials, and may be kept clean and neat with a minimum of effort.

A newly laid poultry house floor should be allowed sufficient time to dry thoroughly before being used, as fresh concrete contains considerable moisture. If time is a factor, it is best to install the floor first and build the superstructure afterward.

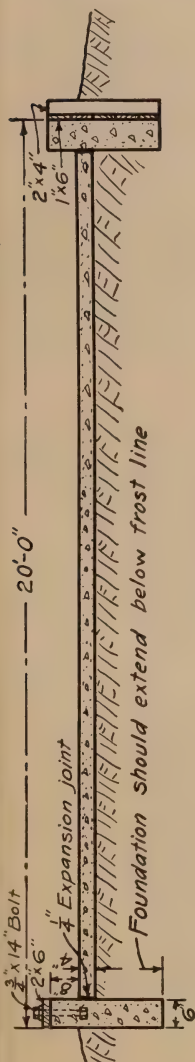
Method

The footings and walls of a poultry house should be built first, and after removing the forms, the backfill of earth should be soaked with water and well tamped in place to insure against settling under the floor after it is laid.

Drainage must be provided for by using drain tile to carry off ground water, especially on the uphill side of the structure. It is always a good plan to lay a sub-floor of cinders or gravel in clay soils.

The concrete for the walls should be mixed in proportions of 1:2:4, being 1 part of portland cement, 2 parts of sand, and 4 parts of stone or gravel graded in size from $\frac{1}{4}$ inch to $1\frac{1}{2}$ inches. One hand stones may be used sparingly in these walls, care being taken to keep them from touching one another or laying against the forms.

The concrete for the floor should be mixed in proportions of 1:2:3 $\frac{1}{2}$ and should be at least four inches thick. If possible, the concrete should be machine mixed and the water content kept low.



It should be finished with a wooden float only, and allowed to cure at least a week before being used. It should be kept wet during the curing period, in order that it may attain its full strength.

Materials

Walls, 19 feet x 39 feet x 3 feet inside

Mixture, 1:2:4

Concrete, 177 cu. ft.

Lehigh Cement.....33 sacks

Sand, $\frac{1}{4}$ inch and under..... $2\frac{1}{2}$ cu. yds.

Stone, $\frac{1}{4}$ inch to $1\frac{1}{2}$ inches... 5 cu. yds.

Plums, 4 inches and under.... 2 cu. yds.

Floor, 19 feet x 39 feet x 4 inches

Mixture, 1:2:3 $\frac{1}{2}$

Concrete, 247 cu. ft.

Lehigh Cement.....46 sacks

Sand, $\frac{1}{4}$ inch and under..... $4\frac{2}{5}$ cu. yds.

Stone, $\frac{1}{4}$ inch to 1 inch..... $7\frac{3}{5}$ cu. yds.



Poultry house with a concrete floor and a rear wall as high as the dropping boards. The two-story building at the far end is a feed house



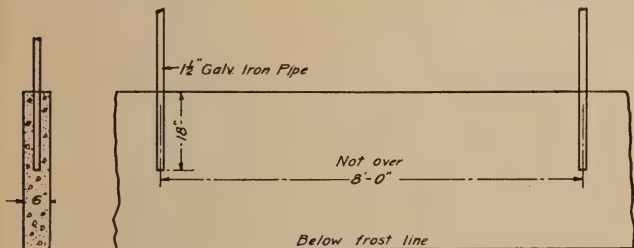
Hog Runs

THERE is no material superior to concrete in improving the appearance of farm buildings.

This picture shows what one man has done with his hog runs. Concrete for this work has eliminated the necessity of constant replacements, and has changed an unattractive and unsanitary yard to a neat, clean run which will last indefinitely with no further expense.

Method

The walls are built six inches thick, the base being set below the frost line without spread footings. The



Elevation of hog run wall

forms should be built in sections, eight or ten feet long, if there is any considerable amount of wall to build. Studs spaced 18 inches apart should provide a rigid wall form that can be set and reset accurately until the job is completed.

The concrete should be mixed in proportions of 1:2½:4, being 1 part of portland cement, 2½ parts of sand, and 4 parts of stone or gravel, graded in size from ¼ inch to 1½ inches.

The concrete should be machine mixed if possible, to insure uniformity of mixture and water content, which should be kept as low as possible consistent with workability. It should be placed in the form in layers and thoroughly spaded to insure consolidation of aggregates.

The iron pipe for the fencing should be buried in the soft concrete at stated intervals as soon as possible after the concrete is placed, to insure a satisfactory bond. A tee or union at the bottom of the pipe further insures its stability. Care must be used to set the fence pipe plumb and all the same height.

After the forms are removed the surface of the wall may be rubbed with an abrasive stone to remove form marks. Fencing should not be set up until the concrete is at least two weeks old, as the strain on the posts may otherwise fracture the concrete.

Materials

50 feet of hog run wall, 4 feet 6 inches deep

Mixture, 1:2½:4

Concrete, 112½ cu. ft.

Lehigh Cement.....23 bags

Sand, ¼ inch and under.....2⅙ cu. yds.

Stone, ¼ inch to 1½ inches...3½ cu. yds.



Hog Houses

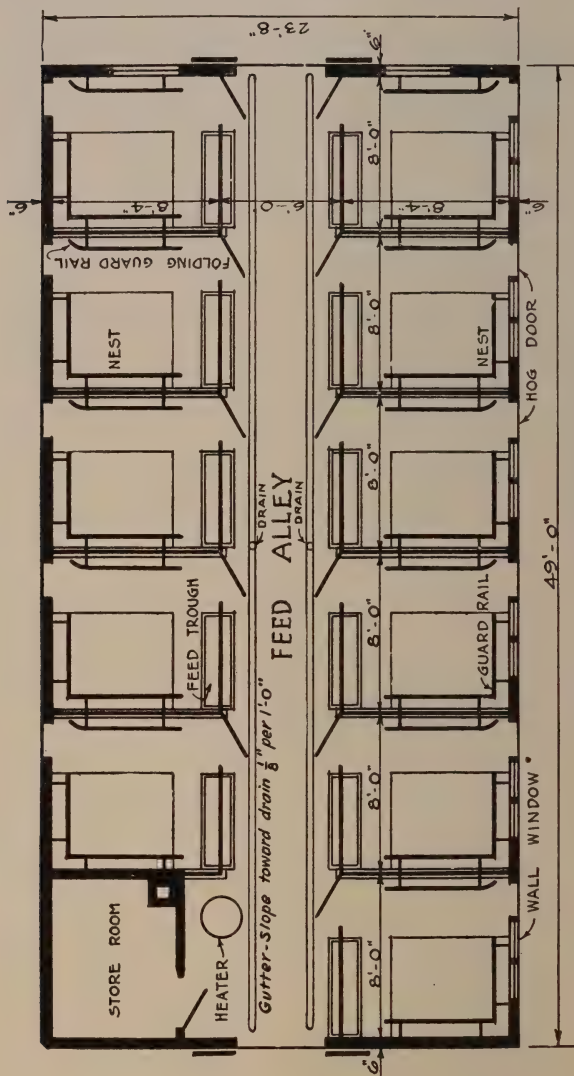
CONCRETE is generally used in building a modern sanitary hog house, plans for which are very nearly standard throughout the country.

Method

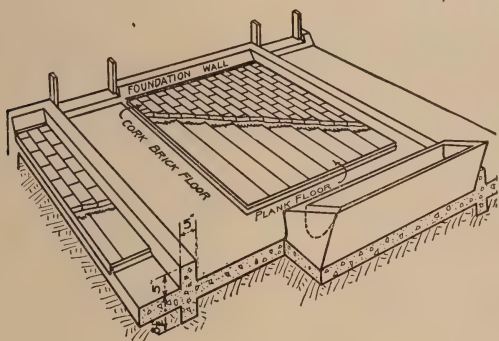
The sketch and picture indicate the layout most commonly used in building a hog house.

The foundations and superstructure are similar to those in any other farm building. The floor is laid over a well-tamped earth subgrade, and at each stall there is a small footing built properly to support the heavy pipe posts and wire panel.

The floors, panel footings, and feed troughs are all made of concrete mixed in proportions of 1:2½:4, being 1 part of portland cement, 2½ parts of sand,



Floor plan of typical modern hog house



and 4 parts of stone or gravel, graded in size from $\frac{1}{4}$ inch to 1 inch. It should be machine mixed if possible, to insure proper proportioning and to keep the water content low. Floors should be finished with a wood float only.

Set the forms and pour the panel footings and bases first, into which the panel posts are set while the concrete is being placed. After the forms are removed the pen floors are poured together with the feeding troughs.

Materials

One panel footing and base, 5 inches by 9 inches by 8 feet

Mixture, 1:2 $\frac{1}{2}$:4

Concrete, 2 $\frac{1}{2}$ cu. ft.

Lehigh Cement..... $\frac{1}{2}$ sack

Sand, $\frac{1}{4}$ inch and under..... $\frac{1}{20}$ cu. yd.

Stone, $\frac{1}{4}$ inch to 1 inch..... $\frac{1}{14}$ cu. yd.

One floor, 4 inches x 8 feet x 8 feet

Mixture, 1:2 $\frac{1}{2}$:4

Concrete, 21 $\frac{1}{3}$ cu. ft.

Lehigh Cement..... 4 sacks

Sand, $\frac{1}{4}$ inch and under..... $\frac{2}{5}$ cu. yd.

Stone, $\frac{1}{4}$ inch to 1 inch..... $\frac{2}{3}$ cu. yd.



Hog Wallows

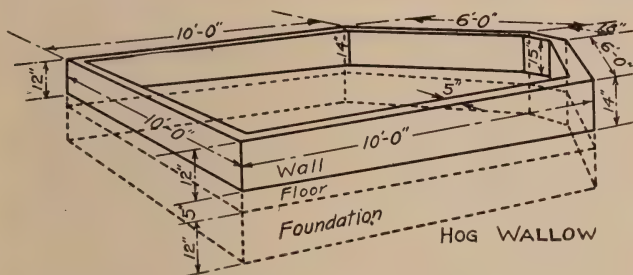
A CONCRETE hog wallow will assist in keeping pigs clean and free from mange and insect pests. Unless a wallow is provided, the hogs will quickly make a disease-breeding mud hole on the hog lot.

Method

As indicated in the plan, this wallow is built with shallow footings on a well-tamped earth foundation. While it is not absolutely essential that a hog wallow be watertight, it is easily accomplished by suspending the inside forms from cross-braces supported by the outside forms. The footings, floor, and walls may then be poured monolithic and consequently watertight.

The sketch indicates the top of the wall level and provides for a pitch in the floor to a drain through which the water may be drawn off into a short line of drain tile.

The concrete should be mixed in proportions of 1:2:3½, being 1 part of portland cement, 2 parts of



sand, and $3\frac{1}{2}$ parts of stone or gravel graded in size from $\frac{1}{4}$ inch to $1\frac{1}{2}$ inches. It should be mixed with the least amount of water to give it workability. The floor should be finished with a wood float to provide firm and non-skid footing for the stock. The walls may be plastered with a thin coat of 1:2 mortar to further insure waterproofness, if desired.

Materials

Mixture, 1:2:3 $\frac{1}{2}$

Concrete, 93 cu. ft.

Lehigh Cement 22 sacks

Sand, $\frac{1}{4}$ inch and under 12 $\frac{2}{3}$ cu. yds.

Stone, $\frac{1}{4}$ inch to $1\frac{1}{2}$ inches . . . 2 $\frac{7}{8}$ cu. yds.

A hog wallow that can be very easily and quickly constructed is illustrated on the next page. In construction of forms, proportion of mix, and method of finishing it is identical with the one just described. The ramp is a decided advantage, however, providing easy entrance, and the forms are a bit easier to construct. In this wallow no provision is made for drainage. The pit is filled by means of a hose, and the water is bailed out when it becomes necessary to clean it. Drainage can, however, be easily provided if desired.



Materials

Footings, 2 feet deep

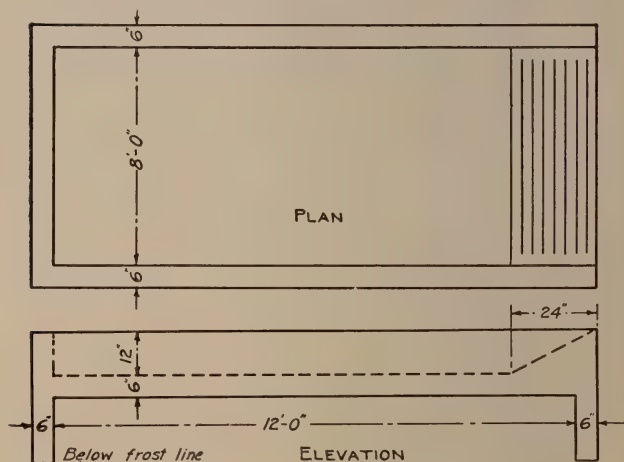
Mixture, 1:2:3½

Concrete, 128¼ cu. ft.

Lehigh Cement 30 sacks

Sand, ¼ inch and under 2¼ cu. yds.

Stone, ¼ inch to 1½ inches... 4 cu. yds.



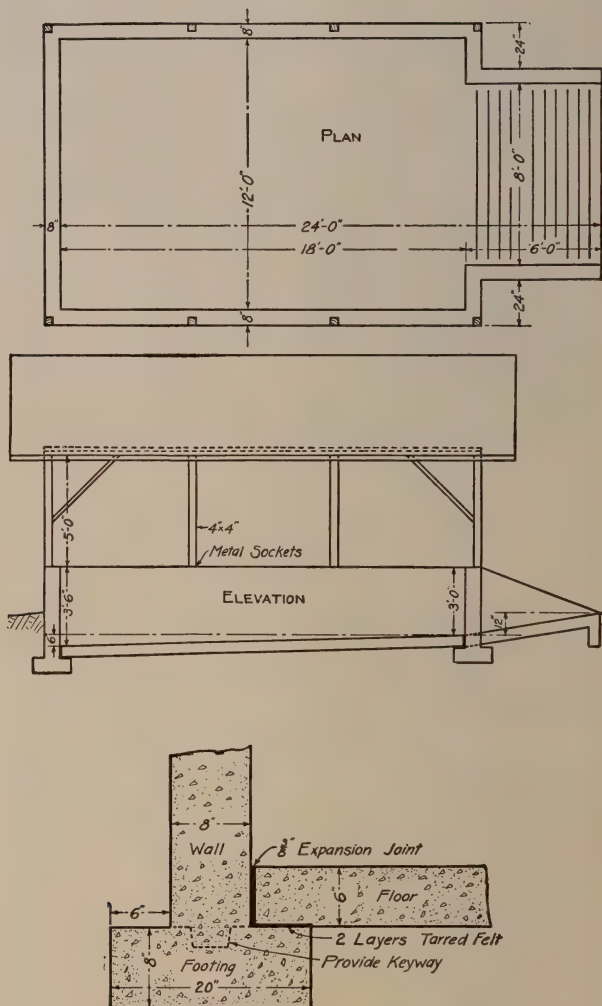


Manure Pits

THE old type of combined barnyard and manure pit is rapidly passing because it is wasteful and unsanitary. The value of manure stored in a tight concrete pit as compared with barnyard storage is so great that the pit will quickly repay its construction cost.

Method

Pour the footings first, and upon them erect forms of inch boards and two by four studs spaced not over 18 inches apart for the walls. The footings and walls should be keyed together to make a tight joint and insure a good bond. After the inside wall forms have been removed, the subgrade should be prepared if the soil is very porous and ground water is present; a line of drain tile around the walls will lead the water away from the pit. The floor should



Detail of wall and floor connection

rest on the top of the footings and a slip joint provided for expansion and contraction. The floor may be finished with a steel float to present a smooth, non-porous surface.

The driveway should be built with an apron or light foundation wall to strengthen it against impact of wagon-wheels, and keep it from sinking in soft ground.

Metal sockets or bolts are embedded in the top of the wall to permit construction of a roof.

All concrete should be mixed in proportions of $1:2\frac{1}{2}:4$, being 1 part of portland cement, $2\frac{1}{2}$ parts of sand, and 4 parts of gravel, graded in size from $\frac{1}{4}$ inch to $1\frac{1}{2}$ inches. It should be machine mixed if possible and the water content should be kept low.

Materials

For large manure pit

Mixture, $1:2\frac{1}{2}:4$

Concrete, 356 cu. ft.

Lehigh Cement.....71 sacks

Sand, $\frac{1}{4}$ inch and under..... $6\frac{7}{8}$ cu. yds.

Stone, $\frac{1}{4}$ inch to $1\frac{1}{2}$ inches... $10\frac{4}{5}$ cu. yds.

The plan on the next page shows a much smaller manure pit. It is built in the same manner as the larger one, however, and the same aggregates and mixture are used.

Materials

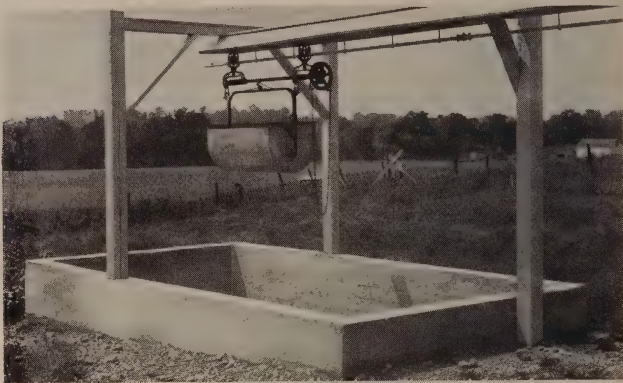
Mixture, $1:2\frac{1}{2}:4$

Concrete, $194\frac{1}{2}$ cu. ft.

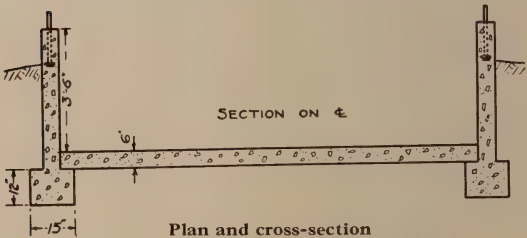
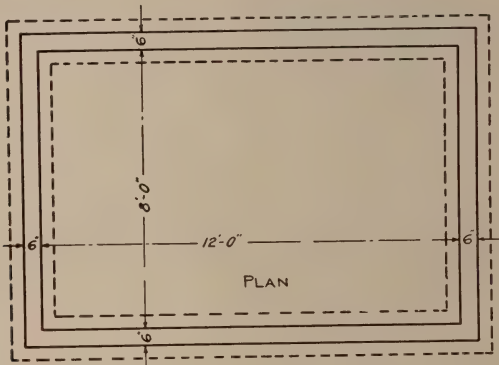
Lehigh Cement.....39 sacks

Sand, $\frac{1}{4}$ inch and under..... $3\frac{3}{4}$ cu. yds.

Stone, $\frac{1}{4}$ inch to $1\frac{1}{2}$ inches... $5\frac{9}{10}$ cu. yds.



Small manure pit



Plan and cross-section



Concrete Piers

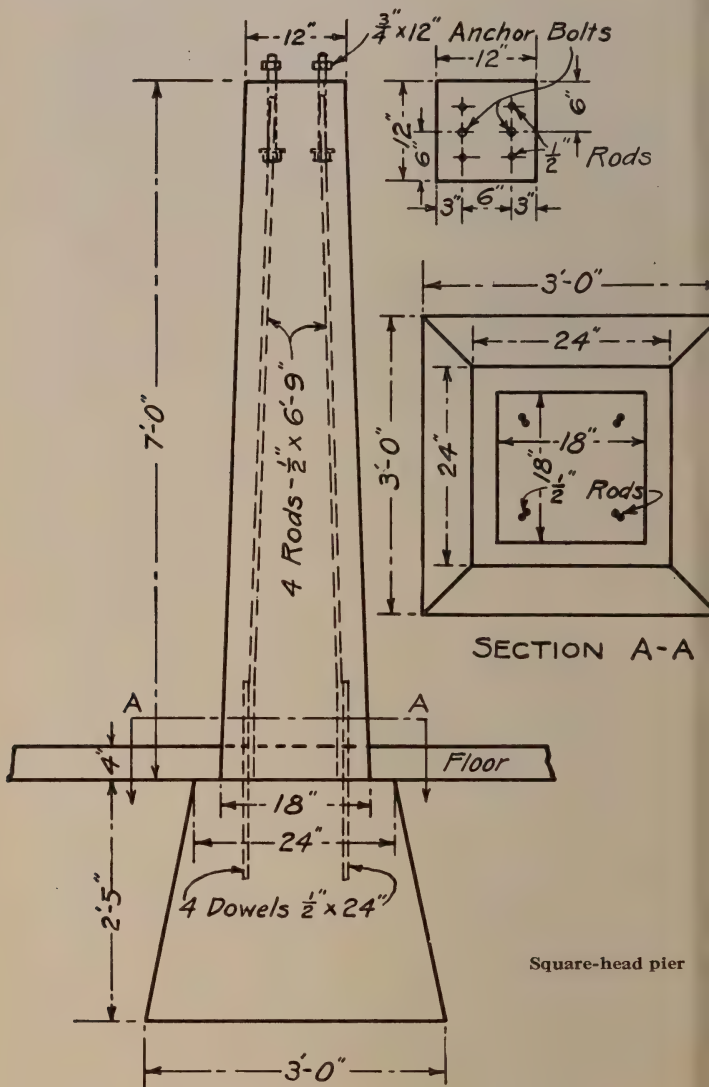
TO ELIMINATE rotting of sills and underpinning of buildings build them of concrete. Sturdy and strong, it will bear its load indefinitely and strengthen with age.

Method

The plans shown here provide for the setting of a steel or timber superstructure.

The forms are set and the piers poured in place. In the first plan provision is made for steel anchor bolts; in the second, T-shaped pier, dowels are used to fasten the rough timber to the pier head.

The manner of setting forms for the pier foundations or footings and the piers themselves are identical, as they are both battered on all sides. The most common practice is to build two opposite sides true to line and set them in place, then the two remaining sides are simply boarded up and studs set in place at the corners. The entire form must be rigidly braced from without and the forms tightly wired



Square-head pier

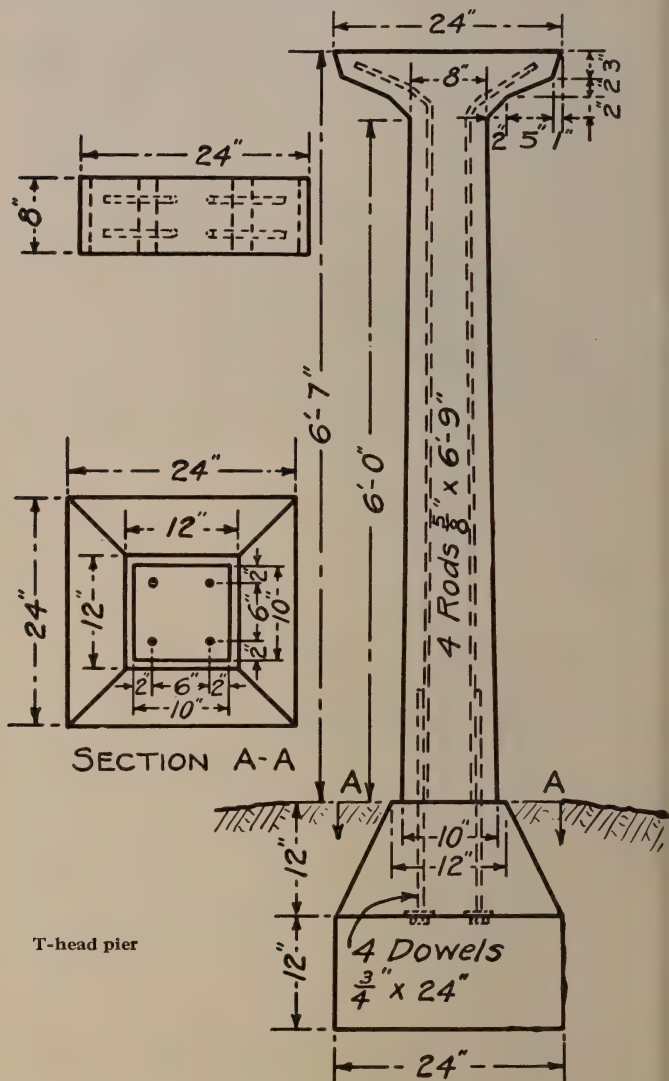


together either by using ties running diagonally from corner to corner through the pier, or by providing collars at stated intervals up the form on the outside. These may be made of several strands of wire or lumber which is tightly wedged in place. Form lumber should be of tongued and grooved material.

The concrete in the footings should be mixed in proportions of 1:2:4, being 1 part of portland cement, 2 parts of sand, and 4 parts of broken stone or gravel, ranging in size from $\frac{1}{4}$ inch to 2 inches. The pier or post concrete should be mixed in proportions of 1:2:3 $\frac{1}{2}$, being 1 part of portland cement, 2 parts of sand, and 3 $\frac{1}{2}$ parts of broken stone or gravel, graded in size from $\frac{1}{4}$ inch to 1 $\frac{1}{2}$ inches.

The placing of the concrete should be done slowly, as large batches deposited suddenly will often spring the forms and cause them to leak.

The pier footings should be allowed to set thoroughly before the forms are set for the posts. When



the footings are poured, set two-foot dowels, as indicated in the plan. To these the post reinforcing must be securely wired before the concrete is poured. Iron piping is not good reinforcing material, nor is wire fencing. Use only approved soft steel rods, and take pains to keep them free from rust, oil and dirt, to insure a satisfactory bond with the concrete.

In setting anchor bolts a template should be made from which they may be hung. This template must be securely fastened to the wall form at the exact location required, in reference to those on other piers and height above the footing, to insure a fit with the holes provided in the steel or timber superstructure.

To allow a little leeway in making the fit it is a good plan to provide anchor bolts threaded to a point which will be eight or ten inches below the surface of the concrete. A nut and washer are placed at this point, and a piece of pipe about twice the diameter of the anchor bolt and long enough to reach to the top of concrete is set over it. This will permit the bolt being pried a bit in any direction.

The completed work should be allowed to cure for at least three weeks before the weight of the superstructure is placed upon it. The forms should not be removed for a week, and when they are, an abrasive stone may be used to erase the form marks and improve the appearance.

The design of foundations of this nature is extremely important, and consequently it is best to have the concrete work planned and designed by a competent engineer or architect who will be able to

compute the weight the piers must support and will design them accordingly.

Materials

For footing of one square pier

Mixture, 1:2:4

Concrete, 16 cu. ft.

Lehigh Cement 4 sacks

Sand, $\frac{1}{4}$ inch and under $\frac{1}{4}$ cu. yd.

Stone, $\frac{1}{4}$ inch to 2 inches $\frac{1}{2}$ cu. yd.

For footing of one T-shaped pier

Mixture, 1:2:4

Concrete, $6\frac{3}{4}$ cu. ft.

Lehigh Cement $1\frac{1}{2}$ sacks

Sand, $\frac{1}{4}$ inch and under $\frac{1}{10}$ cu. yd.

Stone, $\frac{1}{4}$ inch to 2 inches $\frac{1}{5}$ cu. yd.

For one square pier

Mixture, 1:2: $3\frac{1}{2}$

Concrete, 12 cu. ft.

Lehigh Cement 3 sacks

Sand, $\frac{1}{4}$ inch and under $\frac{1}{5}$ cu. yd.

Stone, $\frac{1}{4}$ inch to $1\frac{1}{2}$ inches $\frac{1}{3}$ cu. yd.

For one T-shaped pier

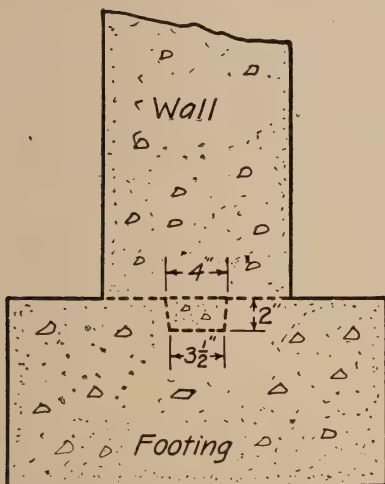
Concrete, $4\frac{2}{3}$ cu. ft.

Mixture, 1:2: $3\frac{1}{2}$

Lehigh Cement $1\frac{1}{2}$ sacks

Sand, $\frac{1}{4}$ inch and under $\frac{1}{10}$ cu. yd.

Stone, $\frac{1}{4}$ inch to 1 inch $\frac{1}{6}$ cu. yd.



Beveled 2"x4" set into footing, when withdrawn, provides keyway

Foundations

FOUNDATIONS for buildings, whatever their type or purpose, should extend below the frost line to eliminate the possibility of movement due to frost action.

Attention must be given to the nature of the soil upon which the building is to be erected. The table given on the next page will be useful in determining whether or not the foundation will be firm. Settlement must be guarded against, and to this end determine the bearing value of the soil at all parts of the foundation. Where soft spots occur they may be bridged by the use of reinforcement near the bottom of the footing concrete.

Spread footings are essential in practically all cases, for they add greatly to the stability of the structure, and in the building of basements they provide a shelf

upon which to lay the concrete floor. In the erection of wall forms they provide a firm and even base upon which to work, and by the use of dowels or keyways firmly anchor the base of the wall in place, this giving ample insurance against springing walls under pressure from without.

A simple method of firmly anchoring the wall to the footing is to set one man rocks into the footing, permitting them to project above the footing line; then, when the walls are poured, the concrete will envelop the upper half of the rocks and make a definite key and bond with the footing.

Another method is indicated in the sketch. A two by four slightly beveled is set into the footing concrete and later withdrawn, providing a substantial keyway, which is filled with the pouring of the wall concrete, thus making a tight joint and strong bond between the wall and footing.

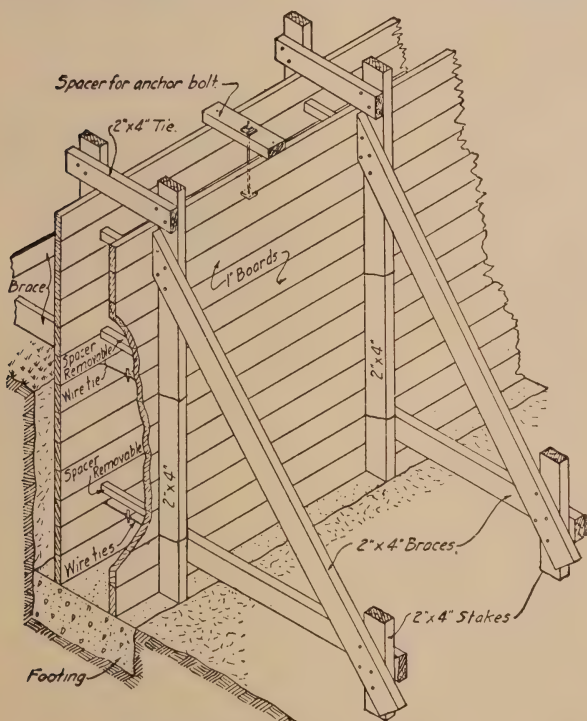
BEARING CAPACITY OF SOILS

Soil	Safe Bearing Power in Tons per Square Foot	
	Minimum	Maximum
Rock, the hardest, in thick layers in native bed.....	200	..
Rock equal to best ashlar masonry....	25	30
Rock equal to best brick masonry.....	15	20
Rock equal to poor brick masonry....	5	10
Clay in thick beds, always dry.....	6	8
Clay in thick beds, moderately dry....	4	6
Clay, soft.....	1	2
Gravel and coarse sand, well cemented.	8	10
Sand, dry, compact, and well cemented.	4	6
Sand, clean, dry.....	2	4
Quicksand, alluvial soils, etc.....	0.5	1

General Notes on Form Construction

IN THE construction of forms for concrete the primary considerations are watertightness, rigidity, strength, and salvage value.

Experience has proved spruce to be a most acceptable and satisfactory lumber for this sort of work. For very careful work, such as ornamental concrete and other small forms, white pine is recommended.



Typical form construction

Norway and Southern pine also may be used with good success. Hemlock, which is so readily available everywhere, does not prove satisfactory, as it splits very easily and has a tendency to curl. On all form work it is advisable to provide sheathing surfaced one side and one edge (S 1 S 1 E), at least, as it is much easier and faster to work with and presents a much smoother and tighter surface to the concrete. Shiplap, or tongue and grooved lumber, is highly desirable in making the form watertight and in rigidly maintaining correct alinement. Studs should be set opposite to each other to facilitate the wiring of the form and must be spaced close enough to prohibit any bulging or weaving in the form line. It is seldom advisable to space studding more than 18 inches apart when using 1 inch sheathing.

Spreaders cut the exact width of the wall are used in spacing the two forms, and wire (usually No. 9) is run through the walls and about the studs; these are twisted until tight, which brings the entire form into position. It is impossible to set any hard and fast rule for the spacing of the wire ties, but it is seldom advisable to spread them further apart than three feet in either direction.

Nails should be used sparingly, and should not be driven completely, for by leaving them out a bit they may be easily pulled when dismantling and salvaging the form lumber.

Crude oil applied to the face of the forms greatly facilitates their removal and serves to preserve the lumber. Oil must not be used, however, on the forms of walls which will later be plastered, as it will make impossible a satisfactory and permanent bond.

In all cases where oil is not used the forms should be well soaked with water just prior to placing the concrete.

Immediately after their removal forms should be scraped free of all concrete, for while it is comparatively green this is not a difficult matter, and by so doing the lumber is made available for other work.

Forms that are built in sections for standard work should be very strongly built of well-seasoned lumber, preferably tongued and grooved. The nails should be securely driven home and holes should be bored big enough to permit pulling the tie wires through without mutilating the lumber.

In butting sections together it is well to use bolts and washers, this method will insure correct alignment and eliminate unsightly offsets in the finished work.

The forms should be serviceable for a great many jobs, if ordinary care is used in handling and storing them. After the work has been completed the forms should be carefully removed, thoroughly cleaned and repaired, after which they should be oiled and stored under cover, if possible.

Steel forms, which are used a great deal for concrete work, can be purchased ready to use equipped with pins and braces for their erection. These are very durable and will last indefinitely if properly cared for.

They should be cleaned and oiled after each installation and when being stored. They should be sheltered from the weather to prevent rust.

The table on next page will be found useful in computing the board feet required in material for forms. Lumber is usually priced per 1,000 F.B.M. One

F.B.M. is a one-inch board one foot long and twelve inches wide, or a two-inch plank one foot long and six inches wide.

TABLE OF BOARD FEET FOR VARIOUS SIZES OF LUMBER

Size of Timber in Inches	Length of Piece in Feet							
	10	12	14	16	18	20	22	24
1x 2	$12\frac{2}{3}$	2	$21\frac{1}{3}$	$22\frac{2}{3}$	3	$31\frac{1}{3}$	$32\frac{2}{3}$	4
1x 3	$21\frac{1}{2}$	3	$31\frac{1}{2}$	4	$4\frac{1}{2}$	5	$5\frac{1}{2}$	6
1x 4	$31\frac{1}{3}$	4	$42\frac{2}{3}$	$51\frac{1}{3}$	6	$62\frac{2}{3}$	$71\frac{1}{2}$	8
1x 5	$41\frac{1}{6}$	5	$5\frac{5}{6}$	$62\frac{2}{3}$	$71\frac{1}{2}$	$81\frac{1}{3}$	$91\frac{1}{6}$	10
1x 6	5	6	7	8	9	10	11	12
1x 8	$62\frac{2}{3}$	8	$91\frac{1}{3}$	$102\frac{2}{3}$	12	$131\frac{1}{3}$	$142\frac{2}{3}$	16
1x10	$81\frac{1}{3}$	10	$112\frac{2}{3}$	$131\frac{1}{3}$	15	$162\frac{2}{3}$	$181\frac{1}{3}$	20
1x12	10	12	14	16	18	20	22	24
1x14	$112\frac{2}{3}$	14	$161\frac{1}{3}$	$182\frac{2}{3}$	21	$231\frac{1}{3}$	$252\frac{2}{3}$	28
1x16	$131\frac{1}{3}$	16	$182\frac{2}{3}$	$211\frac{1}{3}$	24	$262\frac{2}{3}$	$291\frac{1}{3}$	32
2x 4	$62\frac{2}{3}$	8	$91\frac{1}{3}$	$102\frac{2}{3}$	12	$131\frac{1}{3}$	$142\frac{2}{3}$	16
2x 6	10	12	14	16	18	20	22	24
2x 8	$131\frac{1}{3}$	16	$182\frac{2}{3}$	$211\frac{1}{3}$	24	$262\frac{2}{3}$	$291\frac{1}{3}$	32
2x10	$162\frac{2}{3}$	20	$231\frac{1}{3}$	$262\frac{2}{3}$	30	$331\frac{1}{3}$	$362\frac{2}{3}$	40
2x12	20	24	28	32	36	40	44	48
2x14	$231\frac{1}{3}$	28	$322\frac{2}{3}$	$371\frac{1}{3}$	42	$462\frac{2}{3}$	$511\frac{1}{3}$	56
2x16	$262\frac{2}{3}$	32	$371\frac{1}{2}$	$422\frac{2}{3}$	48	$531\frac{1}{3}$	$582\frac{2}{3}$	64
3x 6	15	18	21	24	27	30	33	36
3x 8	20	24	28	32	36	40	44	48
3x10	25	30	35	40	45	50	55	60
3x12	30	36	42	48	54	60	66	72
3x14	35	42	49	56	63	70	77	84
3x16	40	48	56	64	72	80	88	96
4x 4	$131\frac{1}{3}$	16	$182\frac{2}{3}$	$211\frac{1}{3}$	24	$262\frac{2}{3}$	$291\frac{1}{3}$	32
4x 6	20	24	28	32	36	40	44	48
4x 8	$262\frac{2}{3}$	32	$371\frac{1}{3}$	$422\frac{2}{3}$	48	$531\frac{1}{3}$	$582\frac{2}{3}$	64
4x10	$331\frac{1}{3}$	40	$462\frac{2}{3}$	$531\frac{1}{3}$	60	$662\frac{2}{3}$	$731\frac{1}{3}$	80
4x12	40	48	56	64	72	80	88	96
4x14	$462\frac{2}{3}$	56	$651\frac{1}{3}$	$742\frac{2}{3}$	84	$931\frac{1}{3}$	$1022\frac{2}{3}$	112
6x 6	30	36	42	48	54	60	66	72
6x 8	40	48	56	64	72	80	88	96
6x10	50	60	70	80	90	100	110	120
6x12	60	72	84	96	108	120	132	144
6x14	70	84	98	112	126	140	154	168
6x16	80	96	112	128	144	160	176	192
8x 8	$531\frac{1}{3}$	64	$742\frac{2}{3}$	$851\frac{1}{3}$	96	$1062\frac{2}{3}$	$1171\frac{1}{3}$	128
8x10	$662\frac{2}{3}$	80	$931\frac{1}{3}$	$1062\frac{2}{3}$	120	$1331\frac{1}{3}$	$1462\frac{2}{3}$	160
8x12	80	96	112	128	144	160	176	192

Making Good Concrete

By J. C. PEARSON *

AT THE Cement Centennial in 1924 somebody called Portland Cement the "Magic of Concrete." It's not far from the truth when you stop to think about it. Limestone and shale are ground together to the fineness of talcum powder, run into an enormous rotating kiln, where the mixture is burned at hell-roaring white heat until it forms a new chemical substance, discharged from the kiln as a hard clinker, and finally ground again to a gray powder—the finished cement. The making of cement is not a simple nor a small scale process—at all stages of its manufacture it is under close chemical and physical control and a plant to make it costs at least a million dollars. Yet in hardly any section of the country does the material cost as much as a cent a pound, and it will set into a hard, stone-like mass when mixed with a little water and six to eight times its own weight of sand and gravel. Because cement will stand a lot of abuse, there is a tendency for users to think of concrete merely as a mixture of cement, aggregates, and water, and let it go at that.

It is the purpose of this little talk to mention some of the things that are involved in making *good* concrete and avoiding *poor* concrete. It won't interest the technical expert nor the large contractor particularly, but it may hopefully be of some use to the contractor or builder who doesn't have a large

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organization and who must depend upon his own knowledge and experience to plan and execute the work he undertakes.

Of all the concrete troubles that can be traced to materials, the great majority are usually related in some way to poor sand. This matter of sand is so important that it is hard to understand the general indifference among concrete men regarding this particular material. Fortunately for our purpose here, it is easier to specify what a sand should *not* be than exactly what it should be, and we believe that the simple tests described in this book, which every contractor can use to his great advantage, will serve either as a safeguard against bad sand or as a warning against questionable sand.

Sand may be unsuitable in three respects:

1. It may be too fine or otherwise poorly graded.
2. It may contain dangerous organic matter.
3. It may be too dirty.

The gradation of a sand is perhaps its most important characteristic in relation to its concrete-making value. The usual limits for fine and coarse sands are described and illustrated on pages 103 to 105 of this book. A simple recommended test which any one can make to judge the gradation of a sand is as follows: Sift a handful of the dry sand on a No. 30 sieve. If the sand is a first-class concrete sand, this sieve will divide it into, roughly, equal parts, the larger fraction being retained on the sieve. If most of the sand passes through the sieve, it is too fine, and if nearly all is retained on the sieve, it is too coarse. A No. 4 sieve can also be used to advantage in case the sand contains any appreciable

amount of gravel, or in case pit-run material is being tested. It is customary nowadays to designate sand particles coarser than a No. 4 sieve as gravel, and the No. 30 sieve should be used on the sand after the gravel has been removed.

While the gradation of a concrete sand was said to be its most important characteristic, the presence of organic compounds may be a very serious matter in extreme cases. This is a contamination which comes from the slow leaching of water through decomposed overlying vegetable matter, which results in coating the sand grains with an invisible trace of a substance that may interfere seriously with the proper setting of the cement. A method of detecting and roughly measuring the quantity of organic matter in the sand has been developed in the so-called "colorimetric" test, which is fully described and illustrated on pages 100 to 101. This test, like the others here recommended, serves primarily as a warning that the sand may be unsuitable, but, generally speaking, a very light color means a safe sand, and a dark color a dangerous sand.

By dirty sand we mean a sand which contains considerable quantities of clay, silt, or foreign matter, such as leaves, chips, etc. If the dirt is confined to clay and silt, it may or may not be harmful, depending upon its quantity, and also upon whether it forms a hard coating on the sand grains or not. Accordingly, a limit of 3 per cent by weight of the sand is usually specified as the permissible amount of material that may be removed by washing. The field test is a simple volumetric test made as described and illustrated on page 102. This test needs no other

equipment than that required for the colorimetric test described in the foregoing paragraph.

Passing on now to the materials that are commonly used as coarse aggregates, it is comforting to know that where such materials as gravel, crushed stone, or crushed slag are furnished separately to a job (that is, not mixed with fine aggregate), they are in most cases safe and satisfactory, provided, of course, they are hard, clean and free from foreign materials. Cinders, however, are always a questionable aggregate, and there is no general guide by which one can judge their quality, except possibly by previous experience or by making up test blocks in the proportions which are to be used. In general, the use of cinders for concrete exposed to the weather is not recommended. *Good* cinder concrete is not very often found out-of-doors, for if it contains enough cement to be durable, it is not economical. Please understand that these statements do not necessarily apply to cinder concrete blocks manufactured under well-controlled plant processes nor to special uses of cinder concrete where quality is assured by suitable tests.

As stated above, clean coarse aggregates when delivered separately to the job are rarely a source of trouble in concrete work. But some caution must be exercised in the use of bank-run gravel or crusher-run stone. In the case of bank-run gravel, dirt and contamination are more likely to escape notice than in the separated sand and gravel. The proportion of fine material to coarse is very often too large, and always more or less variable, tending to give weak and non-uniform concrete in lean mixtures. In

crusher-run stone or in stone screenings the fines usually contain an excess of dust, which tends to stick to the larger particles, and if this coating of dust is not thoroughly removed in the mixing process, a weak bond between cement and aggregate results. On the other hand, if crusher-run stone or stone screenings has the dust removed by washing or otherwise, there may be a *lack* of sufficient fine material, so that harsh, watery mixtures result from their use, giving pockety, non-uniform, and porous concrete.

This quality of harshness, so characteristic of stone screenings, makes it difficult to produce good concrete without an excess of cement over what would be required for well-graded sand, and therefore an admixture of fine sand with clean stone screenings makes a better and safer aggregate than crusher-run screenings alone.

This brings us to some of the finer points in the art of making good concrete, about which something ought to be said because there is evidence, from the appearance and condition of many jobs, that builders are too often inclined to decide upon a certain proportion of cement, sand, and stone as being strong enough for the job and then going ahead without regard to what the mixture looks like or feels like or behaves like when the concreting is started. Here is where a good concrete man draws upon his real knowledge of concrete, where he needs to know something not covered in specifications, and which he can know only from his own training and experience. A good concrete mixture, whether lean or rich, must be such that it will go into the forms and *fill* them

without excessive labor in puddling or spading. We put the word *fill* in italics because we mean that the forms should be filled with concrete and not with air-holes and pockets. If the mixture is not well graded from cement to coarse aggregate, it will not *fill* properly, and no amount of water will correct this fault. What a concrete mixture needs to fulfil this requirement is a certain degree of plasticity or workability, a property which is hard to define, but one which we can illustrate in the following way: Suppose we make up a concrete mixture by starting with a rich bricklayer's mortar and adding to it gradually some coarse aggregate. At the start we have the mortar alone, which is very plastic and workable; it spreads easily, it can be made to fill any kind of a mold with little effort, and the water does not tend to separate from the mass. As we add the coarse aggregate these qualities become less marked; the mixture becomes harsher, it spreads less easily, more work is required to put it into a mold without leaving air-pockets, and the water tends to separate from the other ingredients. As a rule, this addition of coarse aggregate cannot be carried beyond a proportion of two volumes of aggregate to one of mortar without overloading the mixture and cutting its plasticity or workability below what is required for good concrete. On this account concrete proportions have almost always been required to have at least half as much fine aggregate as coarse, e. g., 1:2:4, 1:2½:5, etc.

This is hardly satisfactory in present-day practice, however, because such aggregates as crushed stone and crushed slag require more mortar to "carry"

them than a rounded aggregate, and a poorly graded aggregate of any kind requires more mortar than a well-graded one. Further than this, the stone-carrying capacity of a mortar depends not only upon the richness of the mortar, but also on the gradation of the sand in the mortar. Every one who has mixed and handled concrete knows that coarse sand or stone screenings make harsh working mixtures.

We cannot specify a definite procedure that will insure good concrete mixtures under all circumstances. This depends upon the peculiarities of the aggregates available. But when a mixture will not go into place with a reasonable amount of effort and *fill* properly, there is something wrong with it, and some adjustment is needed. For this purpose admixtures of hydrated lime and other fine powders are sometimes used, or the desired improvement may be brought about by increasing the quantity of sand. The disadvantage of using admixtures is that additional material has to be delivered to the job, and pound for pound they cost more than cement. The advantage of using an admixture, therefore, must, for economy, be weighed in comparison with the advantage of using a little more cement, with the further thought that an admixture of cement gives added strength as well as increased workability.

One of the most serious aspects of this lack of workability is the very common tendency to compensate for it by increasing the amount of mixing water. One of the most noticeable characteristics of harsh mixtures is that the water separates readily from the mass, and when this happens to any mixture, either in wheeling or placing in the forms, it is

a safe bet that the mixture is too wet. The improvement in workability by adding excess water is apparent only, for segregation of the aggregates is thereby increased, and while the concrete may appear to go into the forms more readily, it goes in less uniformly, and we have in the finished product all the characteristics of poor concrete.

We have said nothing thus far about the well-known and well-advertised effect of excess water in reducing strength. Countless tests have shown that the amount of water in a concrete mixture over and above what is actually required for proper handling *detracts much more from the strength than leaving out the same amount of cement*. In other words, the very common practice of overwetting mixtures is equivalent to throwing away some of the money that has been paid for good cement. If a mixture lacks workability, it cannot be remedied by adding more water—this only makes a bad matter worse.

It does not seem necessary to say very much about the time of mixing or the amount of mixing which is required in making good concrete. Since one of the first requirements of good concrete is that it shall be uniform and homogeneous throughout, the *minimum* amount of mixing is naturally that which will evenly distribute the ingredients throughout the mixture. By the time this condition is reached the aggregate will be properly coated with cement. However, somewhat longer mixing is beneficial because plasticity or workability is thereby increased. This is due to the gradual absorption of water by the cement particles, a chemical action which converts the dry cement powder into glue and turns

the mixture into artificial stone when the glue has hardened. To make this artificial stone of maximum strength and durability the cement and sand must be thoroughly distributed and fill the spaces between the coarse aggregates, a result which cannot be attained if the mixing and placing operations are slighted.

A talk of this sort would not be complete without some remarks on the subject of curing. Probably one reason why so little attention is paid to adequate curing is that, if concrete gets reasonably hard in a few days, so that one cannot scratch it deeply with a nail or kick off a corner with his foot, it seems to be satisfactory without going to the trouble of wetting it or protecting it from sun and wind. This is exceedingly poor judgment, because the strength and the resistance to wear and all the other desirable qualities of good concrete can be increased from 50 to 100 per cent by taking proper care of a job for a few days after it is completed. Again we emphasize the fact that cement is a hydraulic material, and that the hydration or hardening is helped enormously by feeding water to it, especially during the first few days and even weeks after being made into concrete. If concrete makers everywhere could be made to realize that the time to use excess water is *after* the concrete has set and not *before*, there would be a marked increase in the proportion of good concrete to poor. The essence of curing is to prevent fresh concrete from drying out, and the longer this drying out is prevented, the better. It does not matter so much *how* the curing is done, whether it be by leaving the forms in place, by covering the work with

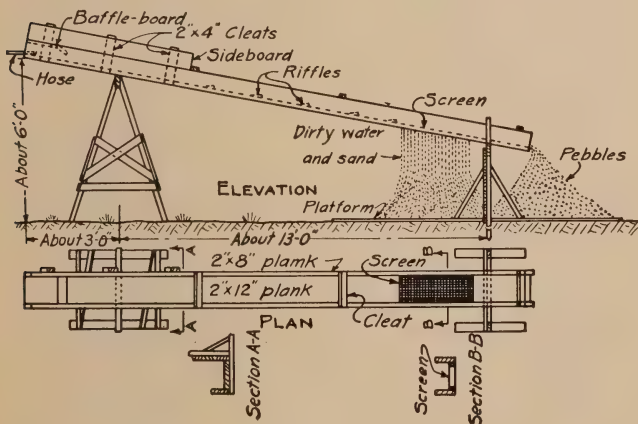
tarpaulins or other protection, by continuous spraying and wetting, or by a combination of all these things—the one object is to keep the concrete from drying out for as long a time as conditions permit.

In conclusion, we should like to make one additional suggestion. Every contractor or builder is concerned with progress and development in concrete construction and should endeavor to keep posted on this subject. If you aren't in the habit of reading books or magazines or articles on concrete, begin now to acquire this habit. Write to the Lehigh Portland Cement Company for its booklets and publications on concrete construction, or ask your dealer to get them for you. Subscribe to one or two magazines in the concrete field and read them.

Concrete Aggregate

THE term "aggregate" is applied to the materials which are used together with Portland Cement in the making of concrete. These materials, sand and gravel, or stone, comprise a very large proportion of the volume of concrete. This fact alone makes very evident the necessity of a careful inspection and selection to insure a satisfactory result.

The general requirements for aggregate are that they be clean, rough, dense, hard, durable, and insoluble. The most abused of these is the first mentioned. Sand or stone which to the eye is very clean is often quite unfit for use in concrete work, generally due to an excess amount of silt or rotted vegetable matter. The quality of sand can often be determined by conducting a few simple tests, which are explained elsewhere in this book. The other requirements are equally important, but are not hard to meet in any locality.



Aggregate is divided into two general classifications, "coarse" aggregate being all material retained on a $\frac{1}{4}$ -inch sieve and "fine" aggregate that passing through a $\frac{1}{4}$ -inch sieve.

Coarse aggregate is gravel or crushed stone. The gravel, pebbles or crushed stone used must be clean, hard, tough and graded in size. The strength of this aggregate will be reflected in the concrete.

Fine aggregate is sand. To make concrete of high strength requires a well-graded sand in size from fine to coarse, as illustrated in plates on pages 103 to 105.

A fine uniform sand is not to be recommended, but the word "sand" frequently suggests this to the inexperienced person.

The use of a small washing plant, such as is shown in the sketch, often makes available sand and gravel which, unwashed, would be wholly unfit for concrete. Such a plant is inexpensive to operate. It washes and grades the material in one operation.

For purposes of estimate only the following table is of value in computing the weight of aggregate. Commercial sand and gravel companies usually provide information regarding the weights of their particular product.

AVERAGE WEIGHTS OF AGGREGATES

Material	Pounds per Cubic Yard
Sand.....	2,700
Limestone	2,400
Granite	2,500
Trap rock	2,700
Crushed gravel	2,800

VOLUME OF CONCRETE FROM VARIOUS MIXTURES

Quantities of materials given in table below have been measured loosely without compacting.

Mixture	Materials			Volume in Cubic Feet	
	Cement in Sacks	Sand in Cubic Feet	Stone in Cubic Feet	Mortar	Concrete
1:1½	1	1½	..	1¾	..
1:2	1	2	..	2 ¹ / ₁₀	..
1:3	1	3	..	2 ¹ / ₅	..
1:1½:3	1	1½	3	..	3½
1:2:3	1	2	3	..	3 ⁹ / ₁₀
1:2:4	1	2	4	..	4½
1:2½:4	1	2½	4	..	4 ⁴ / ₅
1:2½:5	1	2½	5	..	5 ² / ₅
1:3:5	1	3	5	..	5 ¹ / ₅

This table shows very clearly how the sand and cement fill the voids in the large aggregate or stone. Note that in a mix of 1:2:4, being 7 cubic feet of dry material, we get but 4½ cubic feet of concrete, water and all. In other words, the addition of three cubic feet of sand and cement swells the volume of the large aggregate but a half a cubic foot.

This fact makes very evident the importance of keeping the water content as low as possible, not only because it is a space filler which later evaporates, but because of the prime necessity of having the cement and sand fill every void in the large aggregate.

Wet or soupy concrete will frequently result in rocky, porous concrete.

The Colorimetric Test

**1**

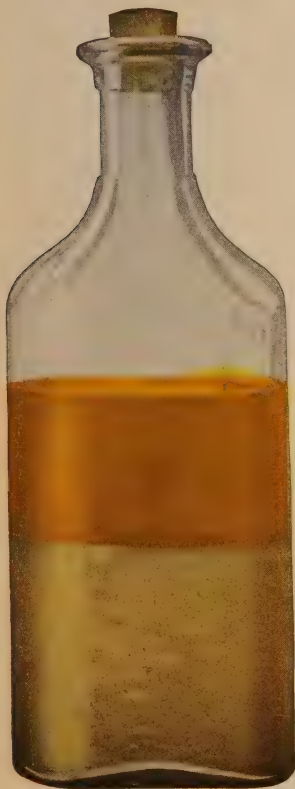
**Sand suitable for work requiring
high grade concrete**

2

**Sand which may be used in less
important work**

To determine the presence of organic matter in sand obtain a 12-ounce graduated bottle and fill to the $4\frac{1}{2}$ -ounce mark with the sand. Add a 3 per cent solution of caustic soda (one ounce of caustic soda dissolved in 32 ounces of water makes a 3 per cent solution) until the combined volume of sand and solution amounts to 7 ounces.

The Colorimetric Test (Continued)



3

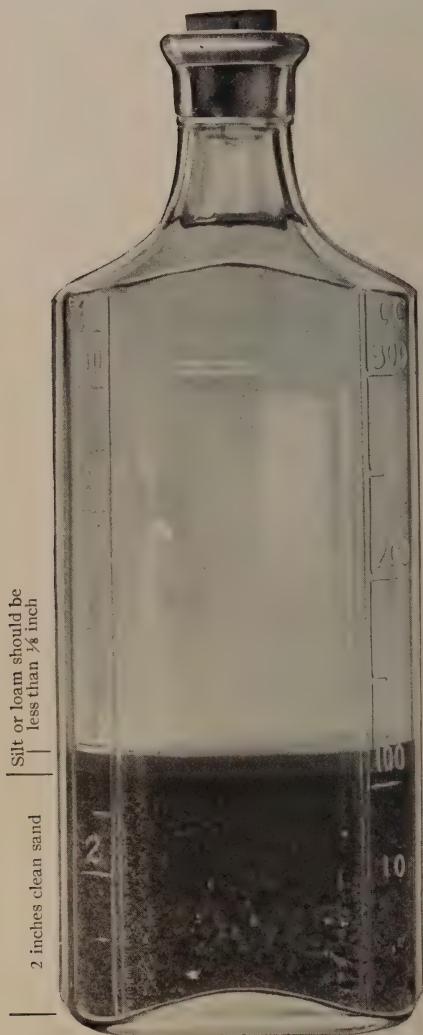
Sand of doubtful quality. Use only for minor work when no better material is available



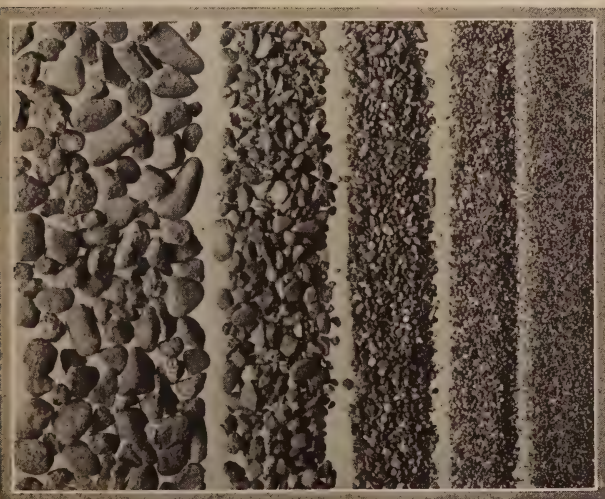
4

Sand which should not be used in concrete

Shake thoroughly for a few minutes, and let stand for twenty-four hours. At the end of this time observe the color of the liquid above the sand. This is an approximate test for the presence of injurious organic matter in sand. It furnishes a warning that further tests of doubtful sand are necessary.

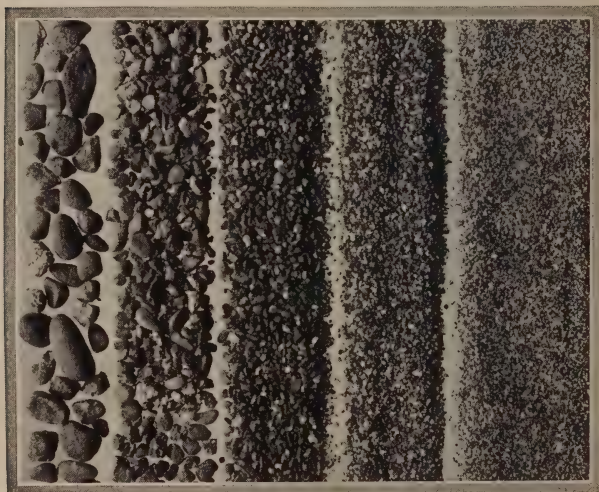


Test to determine quantity of silt or loam in sand

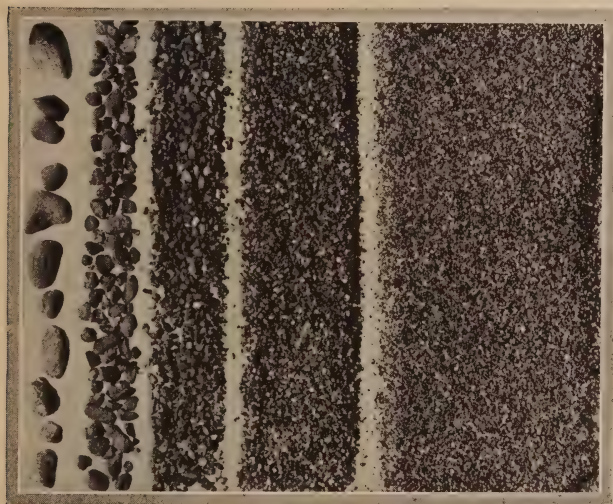


Coarse sand

Will make good concrete but will have to be well spaded



Medium sand
This is almost ideal concrete sand



Fine sand

Sand finer than this will seldom make good concrete

RECOMMENDED PROPORTIONS FOR VARIOUS WORK

	Mixture	Maximum Size Aggregate
Barn approaches	1:2½:4	1½"
Arbors	1:2:3	1"
Areaways	1:2½:4	1½"
Bins	1:2:3	1½"
Boiler settings	1:2:4	2"
Catch basins	1:2:3	1½"
Cellars	1:2:4	1½"
Cisterns	1:2:3	1"
Cold frames	1:2½:4	1"
Courts—tennis and croquet	1:2½:4	1½"
Curbs	1:2:4	1½"
Dipping vats	1:2:3½	1½"
Driveways	1:2½:4	1½"
Engine beds	1:2:4	2"
Fence posts	1:2:3	1½"
Floors	1:2½:4	1½"
Floors, reinforced	1:2:3	1"
Foundations—(mass)	1:2½:5	3"
Gutters	1:2½:4	1½"
Hog wallows	1:2:3	2"
Hotbeds	1:2½:4	1"
Pavements	1:2:3½	2½"
Piers, house	1:2:4	2"
Ratproofing	1:2:4	1"
Retaining walls	1:2:3½	1½"
Roads	1:2:3½	2½"
Roofs	1:2:3	1½"
Runways	1:2½:4	1½"
Sidewalks	1:2½:4	1½"
Steps and stairways	1:2½:4	1"
Slabs	1:2:3	1½"
Septic tanks	1:2:3	1"
Stucco	1:3	¼"
Tanks	1:2:3	1"
Tree surgery	1:3	¼"
Troughs, water	1:2:3	1"
Walls	1:2:4	1½"
Walls subjected to moisture	1:2:3	1½"

These mixtures are suggested as correct under normal or average conditions.

MATERIALS REQUIRED FOR 1 CUBIC YARD OF MORTAR AND CONCRETE

Mixture	$\frac{3}{4}$ " Gravel			1" Stone Dust Out			$2\frac{1}{2}$ " Stone Dust Out			$2\frac{1}{2}$ " Stone Most Small Stone Out		
	Barrels Cement	Cubic Yard Sand	Cubic Yard Stone	Barrels Cement	Cubic Yard Sand	Cubic Yard Stone	Barrels Cement	Cubic Yard Sand	Cubic Yard Stone	Barrels Cement	Cubic Yard Sand	Cubic Yard Stone
Mortar												
1:1	4.48	0.66		Using very	fine sand		4.88	0.72		Using	g coarse	sand
1:1½	3.61	0.80		"	"		3.87	0.86		"	"	"
1:2	3.02	0.90		"	"		3.21	0.95		"	"	"
1:2½	2.60	0.96		"	"		2.74	1.01		"	"	"
1:3	2.28	1.01		"	"		2.39	1.06		"	"	"
Concrete												
1:1:2	2.30	0.35	0.74	2.57	0.39	0.78	2.63	0.40	0.80	2.72	0.41	0.83
1:1:2½	2.10	0.32	0.80	2.29	0.35	0.70	2.34	0.36	0.89	2.41	0.37	0.92
1:1:3	1.89	0.29	0.86	2.06	0.31	0.94	2.10	0.32	0.96	2.16	0.33	0.98
1:1½:3	1.71	0.39	0.78	1.85	0.42	0.84	1.90	0.43	0.87	1.96	0.45	0.89
1:2:3	1.54	0.47	0.73	1.70	0.52	0.77	1.73	0.53	0.79	1.78	0.54	0.81
1:2:3½	1.44	0.44	0.77	1.57	0.48	0.83	1.61	0.49	0.85	1.66	0.50	0.88
1:2:4	1.34	0.41	0.81	1.46	0.44	0.89	1.48	0.45	0.90	1.53	0.47	0.93
1:2:5	1.17	0.36	0.89	1.27	0.39	0.97	1.29	0.39	0.98	1.33	0.39	1.03
1:2½:4	1.24	0.47	0.75	1.35	0.52	0.82	1.38	0.53	0.84	1.42	0.54	0.87
1:2½:4½	1.16	0.44	0.80	1.27	0.48	0.87	1.29	0.49	0.88	1.33	0.51	0.91
1:2½:5	1.10	0.42	0.83	1.19	0.46	0.91	1.21	0.46	0.92	1.26	0.48	0.96
1:3:4	1.15	0.52	0.72	1.26	0.58	0.77	1.28	0.58	0.78	1.32	0.60	0.80
1:3:5	1.03	0.47	0.78	1.11	0.51	0.85	1.14	0.52	0.87	1.17	0.54	0.89
1:3:6	0.92	0.42	0.84	1.01	0.46	0.92	1.02	0.47	0.93	1.06	0.48	0.97

Reinforcing Steel

WORK requiring the extensive use of reinforcing steel, such as columns and floor slabs, should be designed by a competent engineer or architect. His services will assure correct design and remove the danger of failure due to insufficient or misplaced reinforcing material.

Steel is always sold by the pound or ton, and the data given will assist in determining these amounts and facilitate the purchase in accordance with the quantities as shown on the plan of the proposed work.

In the table below are given the areas and weights of square and round bars used for reinforcing steel. Square twisted bars which are used extensively have the same weight as straight-square bars.

AREAS AND WEIGHTS OF REINFORCING STEEL

Size Inches	Round Bars		Square Bars	
	Area Square Inches	Pounds Per Foot	Area Square Inches	Pounds Per Foot
$\frac{1}{8}$	.0123	.042	.0156	.053
$\frac{1}{4}$	.0491	.167	.0625	.213
$\frac{3}{8}$	.1105	.376	.1406	.478
$\frac{1}{2}$	.1963	.668	.2500	.850
$\frac{5}{8}$	.3068	1.043	.3906	1.328
$\frac{3}{4}$	.4418	1.502	.5625	1.913
$\frac{7}{8}$	.6013	2.044	.7656	2.603
1	.7854	2.670	1.0000	3.400
$1\frac{1}{8}$	.9940	3.380	1.2656	4.303
$1\frac{1}{4}$	1.2272	4.172	1.5625	5.313
$1\frac{3}{8}$	1.4849	5.049	1.8906	6.428
$1\frac{1}{2}$	1.7671	6.008	2.2500	7.650
$1\frac{5}{8}$	2.0739	7.051	2.6406	8.978
$1\frac{3}{4}$	2.4053	8.178	3.0625	10.413
$1\frac{7}{8}$	2.7612	9.388	3.5156	11.953
2	3.1416	10.681	4.0000	13.600

MASONRY

Kind	Weight in Pounds per Cubic Foot	Kind	Weight in Pounds per Cubic Foot
Concrete, cinder....	110	Mortar rubble, sandstone.....	130
Concrete, stone.....	140 to 150	Mortar rubble, limestone.....	150
Concrete, reinforced stone.....	150	Mortar rubble, granite.....	155
Brick masonry, soft.	100	Ashlar sandstone...	140
Brick masonry, common.....	125	Ashlar limestone...	160
Brick masonry, pressed.....	140	Ashlar granite.....	165

WEIGHTS OF MATERIAL

Substance	Weight, Pounds per Cubic Foot	Substance	Weight, Pounds per Cubic Foot
ASHLAR MASONRY		VARIOUS BUILDING MATERIALS— (<i>Continued</i>)	
Granite, syenite, gneiss	165	Cement, Portland, set.	183
Limestone, marble...	160	Lime, gypsum, loose..	53-64
Sandstone, bluestone..	140	Mortar, set.....	103
DRY RUBBLE MASONRY		Slags, bank slag.....	67-72
Granite, syenite, gneiss	130	Slags, bank screenings.	98-117
Limestone, marble....	125	Slags, machine slag...	96
Sandstone, bluestone..	110	Slags, slag sand.....	49-55
BRICK MASONRY		EARTH, ETC.	
Pressed brick.....	140	EXCAVATED	
Common brick.....	120	Clay, dry.....	63
Soft brick.....	100	Clay, damp, plastic...	110
CONCRETE MASONRY		Clay and gravel, dry..	100
Cement, stone, sand..	144	Earth, dry, loose.....	75
Cement, slag, etc.....	130	Earth, dry, packed....	95
Cement, cinder, etc....	100	Earth, moist, loose....	78
VARIOUS BUILDING MATERIALS		Earth, moist, packed..	96
Ashes, cinders.....	40-45	Earth, mud, flowing...	103
Cement, Portland, loose.....	90	Earth, mud, packed....	115
		Riprap, limestone.....	80-115
		Riprap, sandstone....	90
		Riprap, shale.....	105

WEIGHTS OF MATERIAL—(Continued)

Substance	Weight, Pounds per Cubic Foot	Substance	Weight, Pounds per Cubic Foot
EARTH, ETC, EXCAVATED—(Continued)		TIMBER, U. S. SEASONED—(Continued)	
Sand, gravel, dry, loose	90-105	Fir, eastern	25
Sand, gravel, dry, packed	100-120	Hemlock	29
Sand, gravel, dry, wet ..	118-120	Hickory	49
		Locust	46
		Maple, hard	43
		Maple, white	33
STONE, QUARRIED, PILED		Oak, chestnut	54
Basalt, granite, gneiss ..	96	Oak, live	59
Limestone, marble, quartz	95	Oak, red, black	41
Sandstone	82	Oak, white	46
Shale	92	Pine, Oregon	32
Greenstone, hornblende	107	Pine, red	30
		Pine, white	26
		Pine, yellow, long-leaf ..	44
		Pine, yellow, short-leaf ..	38
		Poplar	30
		Redwood, California ..	26
TIMBER, U. S. SEASONED		Spruce, white, black ..	27
Ash, white-red	40	Walnut, black	38
Cedar, white-red	22	Walnut, white	26
Chestnut	41	Moisture Contents:	
Cypress	30	Seasoned timber 15	
Elm, white	45	to 20%	
Fir, Douglas spruce	32	Green timber up to	
		50%	

WEIGHTS OF BUILDING MATERIALS

Kind	Weight in Pounds per Square Foot
FLOORS	
$\frac{7}{8}$ " maple finish floor and $\frac{1}{8}$ " spruce under floor on 2" x 4" sleepers, 16" centers, with 2" dry cinder concrete filling.	18
Cinder concrete filling per inch of thickness.	7
Cement finish per inch of thickness.	12
Asphalt mastic flooring 1½" thick.	18
3" creosoted wood blocks on ½" mortar base.	21
Solid flat tile on 1" mortar bed.	23
CEILINGS	
Plaster on tile or concrete.	5
Suspended metal lath and plaster.	10
ROOFS	
Five-ply felt and gravel.	6
Four-ply felt and gravel.	5½
Three-ply ready roofing.	1
Cement Tile.	16
Slate, ¼" thick.	9½

Kind	Weight in Pounds per Square Foot		
	Unplastered	One Side Plastered	Both Sides Plastered
WALLS			
9" Brick Wall.	84	89	..
13" Brick Wall.	121	126	..
18" Brick Wall.	168	173	..
22" Brick Wall.	205	210	..
26" Brick Wall.	243	248	..
4" Brick, 4" Tile Backing.	60	65	..
4" Brick, 8" Tile Backing.	75	80	..
9" Brick, 4" Tile Backing.	102	107	..
8" Tile.	33	38	43
12" Tile.	45	50	55
PARTITIONS			
3" Clay Tile.	17	22	27
4" Clay Tile.	18	23	28
6" Clay Tile.	25	30	35
8" Clay Tile.	31	36	41
10" Clay Tile.	35	40	45
3" Gypsum Block.	10	15	20
4" Gypsum Block.	12	17	22
5" Gypsum Block.	14	19	24
6" Gypsum Block.	16	21	26

MATERIALS REQUIRED FOR 100 SQUARE FEET OF SIDEWALKS AND FLOORS OF VARYING THICKNESS

Concrete base											
Thickness	Mixture 1: 2: 3			Mixture 1: 2: 4			Mixture 1: 2½: 4			Mixture 1: 2½: 5	
	Lehigh cement sacks	Sand cu. yds.	Stone cu. yds.	Lehigh cement sacks	Sand cu. yds.	Stone cu. yds.	Lehigh cement sacks	Sand cu. yds.	Stone cu. yds.	Lehigh cement sacks	Stone cu. yds.
Inches											
2½	5.4	0.40	0.60	4.6	0.34	0.68	4.3	0.40	0.63	3.9	0.36
3	6.5	0.48	0.72	5.6	0.41	0.82	5.2	0.48	0.77	4.6	0.43
3½	7.5	0.56	0.84	6.5	0.48	0.96	6.0	0.56	0.89	5.4	0.50
4	8.6	0.64	0.95	7.4	0.55	1.10	6.9	0.64	1.02	6.2	0.57
4½	9.7	0.72	1.07	8.3	0.62	1.23	7.7	0.72	1.14	6.9	0.64
5	10.8	0.80	1.19	9.3	0.69	1.37	8.6	0.80	1.27	7.7	0.71
5½	11.8	0.88	1.31	10.2	0.76	1.50	9.5	0.87	1.40	8.5	0.78
6	12.9	0.96	1.43	11.1	0.82	1.64	10.3	0.95	1.53	9.2	0.86

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